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THE ELECTRICAL REVIEW

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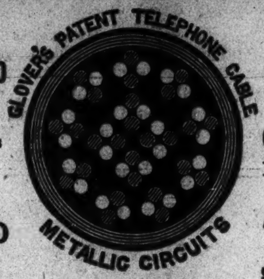

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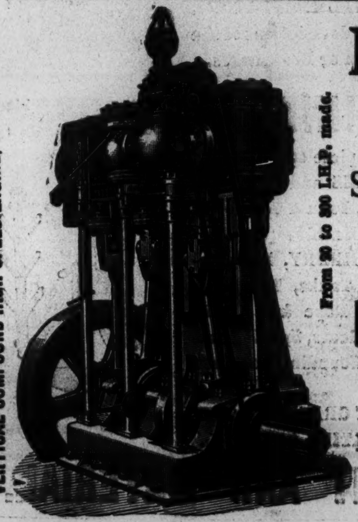

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RAILWAY ACCIDENTS FOR THE YEAR 1890.

It seldom happens but some one fatality of a serious character occurs to mar the returns rendered by the Board of Trade; thus we find in the year under consideration that had it not been for the unfortunate mishap at Norton Fitzwarren, on the Great Western Railway, on November 11th last, by which 10 passengers were killed and 9 others severely injured, the year would have been an exceptionally favourable one so far as regards train accidents.

Mr. Courtenay Boyle, in his remarks upon the general results of the year, pays a somewhat high compliment to the railway officials generally—a compliment that all acquainted with railway working will not only appreciate, but fully endorse. It is quite true that whereas "in some cases the negligence, mistakes, or disobedience to rules of the company's servants were a contributory cause of accident, it must, on the other hand, be admitted that the promptitude and intelligence of the men frequently mitigated the effects of what might otherwise have become disastrous accidents." And he adds: "It should also be pointed out that the difficulties of conducting the railway traffic were greatly added to during the latter part of the year by the abnormally foggy and cold weather that prevailed. Several accidents were largely due to this cause."

The total number of passenger journeys, exclusive of journeys by season ticket holders, was 817,744,046 for the year 1890, or 42,560,973 more than in the previous year. The proportion of passengers killed and injured during the year 1890 from all causes were 1 in 6,930,034 killed and 1 in 600,840 injured.

The number of passengers killed and injured from causes beyond their own control were, respectively, 18 and 496; and the proportion to journeys, 1 in 45,430,224 killed, and 1 in 1,648,677 injured. This is, in its sum total, of course, a great improvement upon the results of 1889, when the number killed was 88, and the number injured 1,016—the numbers for that year having been, as will be remembered, greatly swollen by the Armagh accident. So far, the year 1885 presents the most favourable results, 6 being the number killed, and 436 the number injured. And yet with the larger casualty roll for the past year, when we take into account the greater amount of travelling and the greater number of journeys, we find that the proportion is, in the number injured favourable to the past year; for in 1885 the proportion killed was 1 in 116,202,171, and the proportion injured 1 in 1,599,112. The results of the year cannot then be regarded but with some degree of satisfaction.

The Norton Fitzwarren accident has evidently made a powerful impression upon the Board of Trade, and no opportunity is, judging from the summaries of reports attached to the general report, lost of impressing upon railway companies the propriety of adopting some automatic means of protecting approaching trains where trains are being shunted across or upon opposite lines. How this is to be accomplished, that is, satisfactorily, time only will prove. Many are at work upon the problem, and doubtless something satisfactory will be evolved from the concentration of energy and experience which is being devoted to the subject. The importance of the subject is scarcely to be over-estimated. Many lives have been already lost and much property destroyed solely from want of some efficient means of protection. The prominence given to the whole question by the Fitzwarren accident will, it is to be hoped, result in good. Mechanical energy for a time will no doubt be employed in preference to electrical, because in many minds there still exists a great preference for that which can be seen to do its work, over that which does its duty apparently unseen. The subject is, however, one worthy the attention of electricians, and one which, in our opinion, will only be solved by the aid of electricity.

The report, in the results enquired into and the remarks thereon, appeals more than usually to the electrical profession. Railway electrical engineers will doubtless study the results with attention. In these pages we have from time to time, as opportunity has occurred, advocated the interlocking of the electric with the mechanical signals. The block system is at present but a disjointed means of controlling the movement of trains, and it will never attain maturity, or prove itself of that advantage it ought to be, until the action of the one system of signals is synonomous with the other—until it shall be impossible to work the one without the other. Inventors have not failed to do their part, and the systems which have been produced have not failed in their object, but are in actual operation, although to a limited extent. These are to be found working on the Brighton, London Chatham and Dover, Metropolitan, and Midland. In all cases but that of the Midland, it is true, the interlocking arrangements involve new block instruments. The system used on the Midland is merely an addition to the form of block, viz., the needle block, used upon that line. In cost it should be exceedingly economical, and it is surprising its application has not been more extended. Working, as it has for some time past, a portion of the Midland, Metropolitan, and several sections of the Midland main line system, there can be no question of its reliability. There is no doubt that the application of the automatic brake has been largely instrumental in causing railway companies to defer the interlocking question, and probably the numerous demands of the Board of Trade upon railway companies have also induced that department to defer urging the subject; but it will undoubtedly come to the fore some day, and that at no distant date, for it is clear that our block system will never be complete till this is accomplished. That such is also the opinion of the inspecting officers of the Board of Trade is to be read in their reports; thus, in referring to a report on a collision which occurred on the London and North Western on November 13th, we read :—

"It was pointed out that accidents of this kind arising from a mistake made by one signalman can be prevented by the use of such a system of interlocking the block instruments with the out-of-door signals as is in force upon the Metropolitan Railway, the London Brighton and South Coast Railway, and the London Chatham and Dover Railway."

In relation to a collision on the Great Northern at Colwick, near Nottingham, on January 2nd, we find the following :—

"This could only have arisen in one of two ways. Either the Hall signalman must have omitted to send forward any block signal for one of the goods trains, and have allowed it to proceed without any permission from the Colwick signalman, or the latter signalman, having given permission for both the goods trains to approach, must have forgotten one of them, and have omitted to make any record of the signals referring to it in his book."

"Accidents of this class used to be rather common, but have recently been somewhat rare, and they can only be prevented by a system of interlocking between the block instruments and out-of-door signals."

Again, in referring to a collision on the Lancashire and Yorkshire on December 24th :—"In most cases such accidents might be prevented by an adoption of one of the systems of electrically interlocking the block instruments and outside signals."

The comments of the inspecting officers on the desirability of adopting means for the prevention of casualties consequent upon the shunting of trains across main lines, or placing trains on the wrong road in order to allow of the passage of trains upon the other road, are, as we have said, frequent and unmistakable; thus, in reporting upon the accident on the Great Western on November 11th, it is observed :—

"That all stations where there is much shunting, or where stopping trains are liable to be set aside for fast trains to pass, should be provided with refuge sidings at the proper side of the railway; and that in addition to the present rules, which are very good if carried out, lifting bars may sometimes be advantageously used to lock the signals of the line on which trains have to wait for 'Line clear,' as collisions consequent on the signalman forgetting that he has a train standing at his home or advance signals are not uncommon."

. . . .

"Since the recent serious collision at Norton Fitzwarren (which the present case much resembled) several arrangements have been proposed for endeavouring to provide a means for preventing signalmen forgetting that they have allowed an engine or train to stand on the main line, and lowering their signal for that line."

"If, after being submitted for a sufficient time to the test of practical working, one or other of these arrangements are found to answer, they will no doubt have to be adopted."

In dealing with a collision on the London Brighton and South Coast Railway on December 10th, caused by an empty waggon having, unknown to the signalman, been left standing upon the main line, we find the remark :—

"The inspecting officer was not aware of any practicable mechanical means by which the fact of a waggon having been thus left on the main line could prevent a signalman lowering the signals for that line. It might be possible electrically to prevent a signalman accepting a train under such circumstances by the insulation of one of the rails between (say) the home and advanced signals, and though, perhaps, the conditions are too unfavourable to permit of perfect dependence being placed upon such electrical arrangements, it might be at any rate worth while to give the system a trial."

Again, with reference to a collision on the North British on November 11th, it is observed that :—

"The best way to prevent the mistake of one signalman causing a collision of this kind would be by the adoption of one of the systems of interlocking the block instruments with the out-of-door signals in use upon a few lines in England."

. . . .

"Another way which has been suggested would be by insulating a certain length of rails, as is done in places in America, and providing electrical arrangements which would lock the block instruments or the necessary signals so long as any axle were standing upon the length of rails insulated."

This plan has not, however, been sufficiently experimented upon in this country to make it certain whether it is reliable, and if not reliable it would be worse than useless."

We are in accord with the concluding observation. Having in view the numerous crossing points, switch connections, &c., we think considerable difficulty would be found in working out this system unless railway engineers are prepared to allow the rails to be insulated in sections. This, we have reason to believe, has more than once been refused, although seeing how freely it is adopted in the States, we are bound to admit we fail to see the logic of the objection.

There is still another point in relation to electric signalling to which we think it well to direct attention. A system has of late obtained under which when a train is standing at a station or junction and another waiting to come in, a signal is provided which authorises the admission of the train under the signal: "Section clear but junction blocked." It is pointed out that this form of permissive block should only be used under exceptional circumstances, such as where the incoming train can be under complete control. In the inspecting officer's remarks on the collision of December 21st, and which are as follows, we completely concur:—

"The inspecting officer stated that, in his opinion, it is dangerous for trains to be allowed to approach Brindle Heath junction down the incline of 1 in 80, over a mile in length, under the 'Section clear but junction blocked' signal, and recommended the company to forbid it.

. . . .

"It was stated that this block signal, which was originally intended to be used for the admission of trains to stations where they have to be connected with other preceding trains which may be standing in the station, is becoming far too generally used, and in such a manner as to minimise the advantages gained from a system of block working.

"It would be better not to use it at all at ordinary junctions, and it should certainly never be used at such places unless the gradients are favourable."

Dealing with an accident on the North British on January 20th, we find:—"The evidence disclosed what, in the opinion of the inspecting officer, was an unsafe method of using the 'Section clear but station blocked' signal. This signal is necessary at stations where trains have to connect, but the regulations as to its use, viz., that trains are to be stopped and the driver verbally cautioned, should be strictly adhered to;" and in relation to another mishap on the same line on the 25th we have the remark:—

"This collision revealed the same misuse of the 'Section clear but station blocked' signal as commented upon in the report on the Maryhill collision."

The progress made during the year in the adoption of block signalling shows that in England and Wales, at the end of 1890, out of 13,395 miles of single and double lines open, 12,597 miles were worked upon the absolute block system. In Scotland, out of 2,904 miles of double and single line 2,075 miles were so worked. In Ireland, out of 2,811 miles of double and single lines open, 834 miles were so worked. It is added that "When the orders made upon the railway companies under the Regulation of Railways Act, 1889, come into full force the absolute block and interlocking system will have to be adopted.

Before concluding our remarks on this report, we think it right to refer to the remarks appended to a collision which took place on the Great North of Scotland line at Aberdeen on June 5th. We quote from the report the facts as there stated. The mishap was between two following trains, one from Peterhead, the other from Keith:—

"The train from Keith arrived at the correct time, and the signalman lowered his up starting signal for it to proceed, but omitted to signal it forward to Aberdeen north cabin upon the block instrument. Consequently, the signalman at Aberdeen north cabin did not lower his signals for the train, which came to a stand at the up distant signal, and remained there for about four minutes.

"When the train from Peterhead arrived at Kittybrewster, it was signalled forward upon the block instrument to Aberdeen north cabin, and the signalman in this cabin lowered his distant signal for it. This signal was taken by the driver of the Keith train, which went forward slowly and was about to stop, in order to detach fish trucks, when it was overtaken by the Peterhead train, which had found the distant signal still off."

. . . .

"An accident of this class is not so likely to happen where the system of block working is positive instead of negative, that is, where the line is considered to be blocked, and permission has to be asked and given for every train to proceed, instead of being considered to stand clear as soon as the preceding train has been signalled as having arrived, no further permission for the next train to proceed, no matter how long afterwards, being required."

We are not at all at one with the inspecting officer here. In the first place, it appears to us that the most effectual course for preventing accidents arising out of forgetfulness or erroneous signalling, as was the case here, would be the adoption of an efficient means of interlocking the electrical with the mechanical signals. If this had been in operation the Kittybrewster signalman could not have let the first train go forward without signalling it; or if the system of signalling was that indicated, he could not have allowed the second train to enter the section till the first was clear of it. In the second place, although the majority of railways now work their block on the positive system—that is, only clearing the road for an approaching train—there are reasons against this system quite as potent as those in favour of that recommended. There can be no question that a signal which says the line is blocked when it is clear is not quite so logical a signal as is desired; nor can it, one would say, exercise the same influence over drivers as that signal when on at danger is known to mean danger, and that a train is in the section. No doubt either system strictly carried out is safe, but in the one instance we have a signal which says danger when danger does not exist, and when men know it does not exist; and in the other a signal which means danger when it indicates danger. Moreover, is that which is termed the "positive" system so readily worked as the other? Can trains be so quickly worked by it? Is there not more signalling? It appears to us that the case is quite open to argument from the opposite point of view to that taken by the Board of Trade inspecting officer.

Flying by means of Electricity.

THERE have been several attempts made to thoroughly solve this problem, but although all have met with failure, there are many persons who still believe that it is only a question of time, and the feat will be accomplished. Of course it is now quite understood that if ever there is a practical air ship it will be propelled by electricity. The latest contributor to the literature of this subject is Prof. John Trowbridge of Harvard University, and this is his view. There is an abstract of his article in the American *Chautauquan*, in which he describes the two latest methods suggested for the purpose. One is the telpherage system, which has been tried in Great Britain, for transporting small packages by means of an electric motor running on a species of elevated railway, and as this can be practically an air line, deep cuttings, tunneling and sharp curves can be avoided. This method, however, is not flying in the pure sense. The other system, which is thought to be the coming one, is based upon the employment of storage batteries. Briefly it is this : A light storage battery capable of containing at least one horse-power is to turn an electric motor in a suitable air ship, and by the means of a light source of power and a light motor the problem is to be solved. It is not probable that the future bicyclist of the air can do with less than one horse-power at his command, but he will find it difficult to construct an electrical motor yielding a horse-power, and at the same time weighing under 100 lbs. With 100 lbs. in the battery, 100 lbs. in the motor, and the weight of the gears, wings, and rudders, of the flying machine, the aeronaut will be greatly inconvenienced even for a short trip, and should he gain an initial velocity he will soon find himself upon the débris of his machine, as it is most improbable that a flying machine with such weights could be made to soar. A lighter storage battery might be invented, but the weight of the electric motor will still remain necessarily great.

National Laboratories.

THE somewhat pedantic address of Professor Oliver Lodge, as President of the Mathematical and Physical Section of the British Association, has once more drawn attention to the oft-suggested advisability of establishing a National Laboratory for Physical Research. The argument that because astronomy and meteorology are provided for, therefore other branches of science ought to be similarly dealt with, is, no doubt, forcible, but if it were carried to its logical conclusion, it would involve an enormous outlay, considering the vast ground covered by the physical sciences. The suggestion that such a laboratory might impose on outside workers as a central authority, from which infallible dicta were issued, is one not to be lightly regarded, though we imagine the way in which the work done at Greenwich and Kew has been carried out has not been such as to lead us to suppose that a fear of them is very likely to be realised.

Standard Cells.

THE Board of Trade report seems to indicate that a really satisfactory electromotive force standard has not yet been obtained. Although it recommends the Clark cell, it does not take the limit of accuracy attainable to be closer than one quarter of one per cent. In the hands of experienced physicists, like Dr. Muirhead, satisfactory results appear to be attained, but it is otherwise with those who attempt to make cells for the first time, even if they follow out as nearly as they can the instructions which have been issued relative to their formation. A valuable feature in the cells, as made by Dr. Muirhead, is their issue in pairs, as by testing one cell against the other, which is easily done at any time, it can be at once seen if any difference between the two exists, and the absence of any marked difference is strong presumptive evidence that they are both nearly correct, and *vice versâ*.

Storage Battery Tests in Germany.

A REPORT on the "Results of measurements with accumulators of Correns and those of Tudor," has just been issued, and we give a general résumé from it. The tests were made at the instigation of the Berliner Elektrischen Beleuchtungs Actien Gesellschaft, which company, we believe, is interested in the Correns storage battery. The measurements with both sets of cells, installed in different places, were made simultaneously on the 11th, 12th, 13th, and 14th of last month. The Correns battery was tested by Mr. G. Germershausen, Prof. W. Kohlrausch, Prof. W. Peukert and Dr. Heim, whilst the Tudor battery was under the observation of Prof. Voller, and Messrs. O. Berner, R. Seifert and G. Conz, all men of mark in the electrical world. It was arranged that both batteries should be subjected to exactly similar treatment. Each set consisted of 50 cells, and the instruments used were those of the Physical States Laboratory at Hamburg in the one case, and standard instruments from the Electrotechnical Institute of the Royal Technical High Schools of Hanover, in the other ; they were first compared with each other and any errors in absolute indications ascertained and accounted for in all calculations.

The Correns Battery.

THIS was of the type with a capacity of 924 ampère hours at a discharge rate of 154 ampères. Each cell contained 21 negative and 22 positive plates with a total surface of 300 square decimeters per electrode. It had been in use during $2\frac{1}{2}$ months previous to these tests. Efficiency tests based on a single charge and discharge are not reliable, therefore the averages of 10 charges and discharges were taken which gave a total mean efficiency of 93 per cent. in ampère hours, and 81·5 per cent. in watt hours. The current density when charging was calculated to be equal to $\cdot 69 \dfrac{\text{ampères}}{\text{square decimetres}}$; when discharging $\cdot 9 \dfrac{\text{ampères}}{\text{square decimetres}}$.

The Tudor Battery.

THIS had been in use for upwards of eight months before the present experiments took place. The cells had a normal capacity of 660 ampère hours at a discharge rate of 198 ampère hours. Each cell contained 16 negative and 15 positive plates with a total surface of 288 square decimetres per electrode. The makers of this battery declined the invitation to take part in the experiments, the experts, however, considered it sufficient that the proprietors of the cells allowed these tests to be made. After charging and discharging this battery under the same conditions as the former set, it was ascertained that the average efficiency in ampère hours was 87·5 per cent., whereas the watt hour efficiency came to 68·8 per cent. The current density when charging averaged $\cdot 61 \dfrac{\text{ampères}}{\text{square decimetres}}$, and the discharge rate was equal to $\cdot 85 \dfrac{\text{ampères}}{\text{square decimetres}}$. The above results give no positive proof of the superiority of one system over the other when reference is made to general efficiency, together with the fact that the useful capacity depends in a measure upon the current density. It must be remarked that the Correns battery was made for a 5-hours' discharge, and the Tudor battery for only 3·3 hours' discharge. These measurements, however, would point to the conclusion that the Correns cells give a higher efficiency than the Tudor cells. The question, which in our mind is most important, is that of durability, and this has not been touched upon, both sets being comparatively new. Our readers are, no doubt, aware that there is no difference in the materials used in the plates forming the distinct types under discussion, although the mechanical arrangements vary somewhat. The manufacturers of the Tudor cells are licensees of the Electrical Power Storage Company, and they maintain that the Correns people infringe their patents. It was on the ground of this alleged infringement that the Hagen Accumulator Company (Tudor) declined to interest itself in the comparative tests instituted by the rival firm.

PRACTICAL PHOTOMETRIC RESEARCH.

By RALPH CONRAD RICHARDS.

Part III.—1.

Experimental Facts, Data, &c., Concerning Illuminants.

Artificial illumination is utilised for two distinct purposes, each of which necessitates a special disposition of the light emitting source.

On the one hand an amount of light sufficient for penetrating considerable distances is required, whilst, on the other, concentration over a comparatively small area is a *sine quâ non*.

In the former case (as, for instance, street lighting), illumination which is sufficiently brilliant to enable the eye to readily determine the position, contour, and a certain amount of the detail of neighbouring objects, affording at the same time, that pleasure which distinct vision only can convey, is necessary. In the latter case, something beyond this is desirable, viz., whiteness; for in order to apply one's self to the ordinary occupations both of reading and writing, physiologists urge the importance of a light approximating to that of ordinary daylight in so far as brilliancy and colour are concerned, in order that the optic nerve may be excited in that manner best calculated to afford both comfort and healthful exercise. Physiologically speaking, an organ should be allowed its fullest scope of employment or action, for a similar reason to the law which informs us that a man whose life is the least artificial will engage himself in the greatest variety of both physical and intellectual exercise in order that all his faculties may develop relatively; thus, also, it is with the organs of both audition and vision, conversation upon one topic is expressively summarised as monotonous.

A parallel instance occurs in monochromatic or incomplete excitation of the optic function of the eye. It follows, therefore, that white light is far preferable to any other, in so far as useful domestic illumination is concerned, and as a generality, the nearer this state of things is approached, the more advantageous will be the result.

In this article it is proposed to deal with the location of illuminants as they affect the requirements of modern life, it being, of course, only necessary to discuss the employment of the electric light, as being best calculated to satisfy the conditions already stated.

In the first case it should be assumed that, for reasons already stated by the writer in the first section of this paper, all artificial illumination is inefficient when the eye encounters both the direct and reflected beams from the light source, whatever this may be; it becomes, therefore, a problem of the highest importance to ascertain the best position to fulfil all the salient points of the question, these are :—

1. To shade the direct rays from reaching the eye; and
2. To admit the greatest possible utilisable percentage.

These two points are best studied in special reference to the particular conditions to be fulfilled in each case.

For purposes of study a bright white light is desirable; this should be arranged, for the sake of economy, as near as possible to the work and out of sight; a back light is the most efficient; for with the ordinary table and students' lamps, there is a continual tendency to look towards the light; this tendency when unchecked, causes a strain upon the optic nerve, which cannot be otherwise than hurtful or disturbing in its influence.

The writer has made several experiments with a standard candle, and from them deduces the fact that the position of maximum efficiency is about two feet above the work, the light being situated in a vertical line from the back of the neck, when the head is bent forward, as in study; although this is the position of maximum efficiency, it must not be imagined that the light of one standard candle, located in the position indicated, is sufficient, for experiment proves that from 15 to 20 candle-power is necessary, it being unnecessary to add that when incandescent lamps are used, the broad side of the filament should face the work, and that a white or silvered shade should be employed.

Strange as it may appear, the rest of the apartment should be illuminated, for without this, many persons soon become restless; this is proved on experiment, it being found that a very slight additional illumination is sufficient to allay this restlessness, and this addition could not of itself explain the phenomena. The writer was long puzzled by this, and finally the idea occurred to him that it could be traced to the obtuse angle of vision of the eye taking in both the illuminated and unilluminated areas, the resultant action being due to the different intensity of various parts of the field of view, which was neutralised—or at least partly so—when the extra light source was employed; a parallel case is cited in the first article of this series—Electrical Review, January 30th, 1891. In the subjoined table the illumination required for almost all purposes is expressed as the distance in feet from the standard candle; and it should be emphasised that in all cases shaded lights should be employed.

Table I.

No.	Light suitable for	Intensity.
	Domestic Purposes.	
1 ...	Corridors, passages, halls, landings, &c. ...	2·5
2 ...	Rooms	2·
	Churches.	
3 ...	General light	4·
4 ...	Pew and reading desk	·5 to ·3
	Library.	
5 ...	General light	4
6 ...	Reading table	·5
	Workshop.	
7 ...	General light	5
8 ...	Benches	·3
9 ...	Optical or delicate scientific work	·2
	Street Lighting.	
10 ...	Road or pavement	10
11 ...	Walls	8
	Theatre.	
12 ...	General light	3
13 ...	Public halls, ships' saloons, &c.	3
14 ...	Private ships' cabins, bedrooms, &c. ...	5

Where a considerable area is to be lighted much subdivision will be found advantageous where economy is important; an installation consisting of 10 5-C.P. lamps properly located is vastly superior to one of a single lamp equal to the sum of the former 10 lamps—or 50 C.P., *ceteris paribus*; not only on account of the lesser contraction of the pupil (which exercises an enormous influence upon the resulting efficiency), but also since by subdividing the light a more homogeneous illumination is secured, whereas in the latter case the area in the immediate vicinity of the lamp will be extravagantly illuminated; conversely the remoter parts receive but a meagre amount of light radiation in proportion to the central parts. This principle of subdivision pervades the whole field of illuminative science, whether electric or otherwise; although deductions should be made from existing installation work as to the proper limit to which this should be carried. Extreme measures are never successful and street lighting by means of incandescence is, it is generally conceded, a failure financially. In this case, small arc lamps of the type illustrated in the last issue but one of this journal, but provided with the arrangement suggested by the author in his first section (already referred to), would be the correct thing. Perhaps the whole question of street lighting might be conveniently studied by a proper combination of diagram 1, and the law of inverse squares. The former of these is the usual diagram of

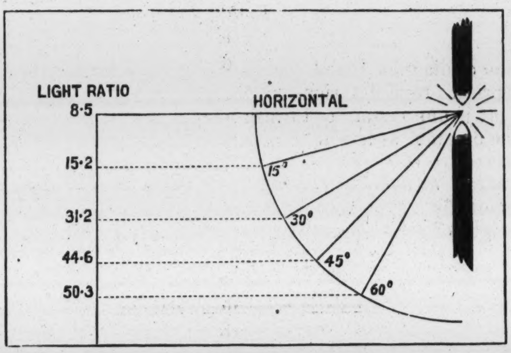


Fig. 1.

the ratio of rays at various angles (the electric arc being the radiant); the numbers as usually given are absurdly conflicting, but if in the figure given these are only considered as ratios of no particular individual value, a very fair idea of the distribution will be gained, although slight modifications and discrepancies will be introduced if the figure be used for arcs of more than 4,000 C.P.; beyond this figure, larger carbons, different ratio of E.M.F. and current, heavier regulating mechanism, will all tend to alter the correctness of the ratios given. Diagram 2, A, B, and C, is a combination of diagram 1, and the law of inverse squares; the circles represent rays at various angles.

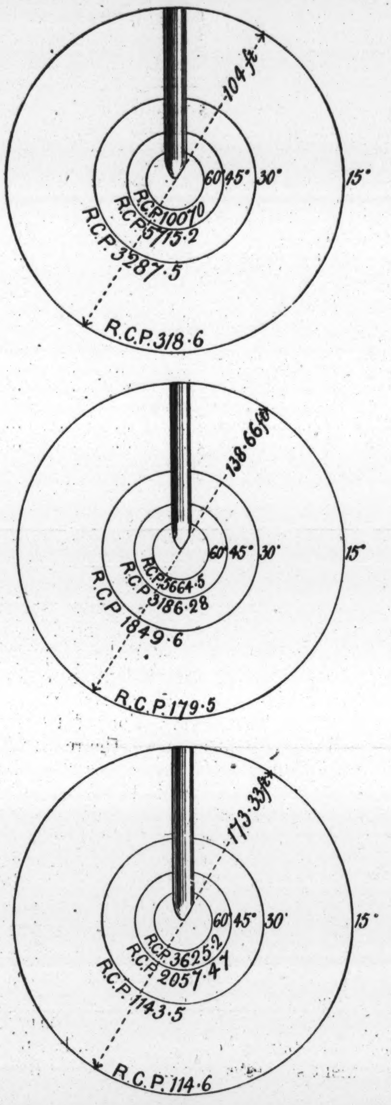


FIG. 2.

It is unnecessary to furnish more figures than are given in the diagram as it will be seen that the interval between two successive concentric circles is generally merely an approximating area by which the two concentric degree limits gradually merge into an average. From this diagram the height of poles to give the best result may be gauged.

(*To be continued.*)

Church Lighting in Canada.—The church of Notre Dame in Montreal, Canada, has been installed with the electric light. The plant consists of two dynamos driven by a 60 H.P. Waterbury engine, the steam for which is supplied by two Babcock boilers. The number of incandescent lamps employed in the illumination of the church, amount to 400.

REPORT OF THE BOARD OF TRADE COMMITTEE ON ELECTRICAL STANDARDS.

THIS report, which has recently been issued, contains the whole of the somewhat voluminous discussions which took place, and the evidence which was given, at the various meetings of the committee. The resolutions which were agreed to are as follows:—

1. That it is desirable that new denominations of standards for the measurement of electricity should be made and approved by Her Majesty in Council as Board of Trade standards.

2. That the magnitudes of these standards should be determined on the electro-magnetic system of measurement with reference to the centimetre as unit of length, the gramme as unit of mass, and the second as unit of time, and that by the terms centimetre and gramme are meant the standards of those denominations deposited with the Board of Trade.

3. That the standard of electrical resistance should be denominated the ohm, and should have the value 1,000,000,000 in terms of the centimetre and second.

4. That the resistance offered to an unvarying electric current by a column of mercury of a constant cross sectional area of 1 square millimetre, and of a length of 106·3 centimetres at the temperature of melting ice may be adopted as 1 ohm.

5. That the value of the standard of resistance constructed by a committee of the British Association for the Advancement of Science in the years 1863 and 1864, and known as the British Association unit, may be taken as ·9866 of the ohm.

6. That a material standard, constructed in solid metal, and verified by comparison with the British Association unit, should be adopted as the standard ohm.

7. That for the purpose of replacing the standard, if lost, destroyed, or damaged, and for ordinary use, a limited number of copies should be constructed, which should be periodically compared with the standard ohm and with the British Association unit.

8. That resistances constructed in solid metal should be adopted as Board of Trade standards for multiples and submultiples of the ohm.

9. That the standard of electrical current should be denominated the ampère, and should have the value, one-tenth (0·1), in terms of the centimetre, gramme, and second.

10. That an unvarying current which, when passed through a solution of nitrate of silver in water, in accordance with the specification attached to this report, deposits silver at the rate of 0·001118 of a gramme per second, may be taken as a current of 1 ampère.

11. That an alternating current of 1 ampère shall mean a current such that the square root of the time average of the square of its strength at each instant in ampères is unity.

12. That instruments constructed on the principle of the balance, in which, by the proper disposition of the conductors, forces of attraction and repulsion are produced, which depend upon the amount of current passing, and are balanced by known weights, should be adopted as the Board of Trade standards for the measurement of current, whether unvarying or alternating.

13. That the standard of electrical pressure should be denominated the volt, being the pressure which, if steadily applied to a conductor whose resistance is 1 ohm, will produce a current of 1 ampère.

14. That the electrical pressure at a temperature of 62° F. between the poles or electrodes of the voltaic cell known as Clark's cell, may be taken as not differing from a pressure of 1·433 volts, by more than an amount which will be determined by a sub-committee appointed to investigate the question, who will prepare a specification for the construction and use of the cell.

15. That an alternating pressure of 1 volt shall mean a pressure such that the square root of the time average of the square of its value at each instant in volts is unity.

16. That instruments constructed on the principle of Sir W. Thomson's quadrant electrometer, used idiostatically, and for high-pressure instruments on the principle of the balance, electro-static forces being balanced against a known weight, should be adopted as Board of Trade standards

for the measurement of pressure, whether unvarying or alternating.

The following is the specification referred to in Resolution 10:—In the following specification the term silver voltameter means the arrangement of apparatus by means of which an electric current is passed through a solution of nitrate of silver in water. The silver voltameter measures the total electrical quantity which has passed during the time of the experiment, and by noting this time the time-average of the current, or if the current has been kept constant, the current itself, can be deduced.

In employing the silver voltameter to measure currents of about 1 ampère the following arrangements should be adopted. The cathode on which the silver is to be deposited should take the form of a platinum bowl not less than 10 cm. in diameter, and from 4 to 5 cm. in depth.

The anode should be a plate of pure silver some 30 square cm. in area and 2 or 3 millimetres in thickness.

This is supported horizontally in the liquid near the top of the solution by a platinum wire passed through holes in the plate at opposite corners. To prevent the disintegrated silver which is formed on the anode from falling on to the cathode, the anode should be wrapped round with pure filter paper, secured at the back with sealing wax.

The liquid should consist of a neutral solution of pure silver nitrate, containing about 15 parts by weight of the nitrate to 85 parts of water.

The resistance of the voltameter changes somewhat as the current passes. To prevent these changes having too great an effect on the current, some resistance besides that of the voltameter should be inserted in the circuit. The total metallic resistance of the circuit should not be less than 10 ohms.

Method of making a Measurement.

The platinum bowl is washed with nitric acid and distilled water, dried by heat, and then left to cool in a desiccator. When thoroughly dry it is weighed carefully.

It is nearly filled with the solution, and connected to the rest of the circuit by being placed on a clean copper support to which a binding screw is attached. This copper support must be insulated.

The anode is then immersed in the solution so as to be well covered by it and supported in that position; the connections to the rest of the circuit are made.

Contact is made at the key, noting the time of contact. The current is allowed to pass for not less than half an hour, and the time at which contact is broken is observed. Care must be taken that the clock used is keeping correct time during this interval.

The solution is now removed from the bowl and the deposit is washed with distilled water and left to soak for at least six hours. It is then rinsed successively with distilled water and absolute alcohol and dried in a hot-air bath at a temperature of about 160° C. After cooling in a desiccator it is weighed again. The gain in weight gives the silver deposited.

To find the current in ampères, this weight, expressed in grammes, must be divided by the number of seconds during which the current has been passed, and by ·001118.

The result will be the time average of the current, if during the interval the current has varied.

In determining by this method the constant of an instrument the current should be kept as nearly constant as possible, and the readings of the instrument taken at frequent observed intervals of time. These observations give a curve from which the reading corresponding to the mean current (time average of the current) can be found. The current, as calculated by the voltameter, corresponds to this reading.

In the use of the standards the limits of accuracy attainable are stated to be as follows:—

For the ohm.—Within one hundredth part of 1 per cent.
For the ampère.—Within one-tenth of 1 per cent.
For the volt.—Within one quarter of 1 per cent.

San Francisco Street Lighting.—It is stated that it costs the people of San Francisco between $250,000 and $300,000 a year to light the streets of the city. This includes the cost of gas, also the cost of electric lights and repairs to lamps.

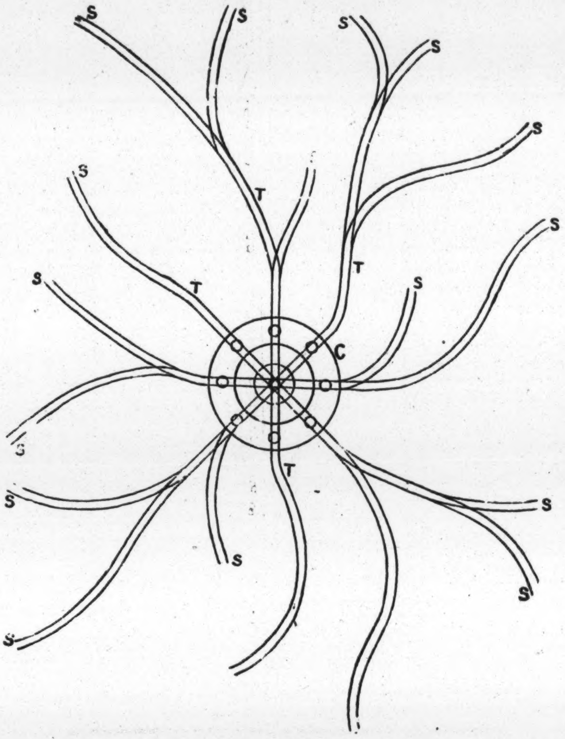
BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE, CARDIFF, 1891.

ON AN ELECTRICAL PARCEL EXCHANGE SYSTEM.

By A. R. BENNETT, M.I.E.E.

(*Read before Section G, August 25th*, 1891.)

THE congested state of the streets in many of the large towns, notably in the City of London, invites reflection as to whether it is not possible to devise means by which vehicular traffic may, to a certain extent, be diminished. To avoid absolute blocking of the thoroughfares, it is now necessary to forbid the collection or delivery of goods in certain localities during business hours, and trade suffers under such restrictions, while warehouses have to be of larger capacity than would be needed were the free receipt and despatch of goods permissible.

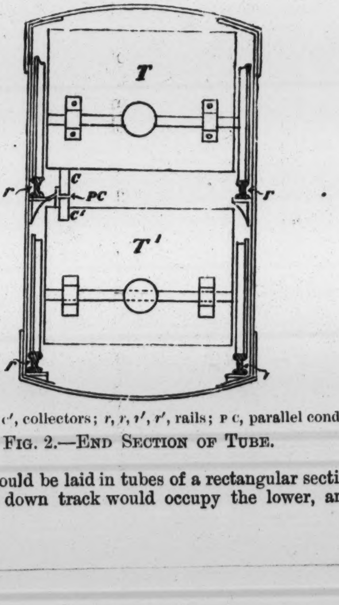


C, central station; S, S, S, subscribers' sidings; T, T, T, T, tubes containing down and up tracks.

FIG. 1.—GENERAL PLAN OF AN ELECTRICAL PARCEL EXCHANGE.

Even if a means could be found for the handling at all times of comparatively small packages the boon would be no inconsiderable one; and with the view of breaking ground in this direction I have worked out a scheme, founded on the telephone exchange idea, whereby parcels can be freely interchanged between any number of buildings, no matter how widely apart they may be situated.

I propose to effect this by means of a number of miniature electric railways, radiating from a central station, and having branches or sidings into all the buildings to be served. The general plan of such a system is shown by diagram 1.



T, T , trains; C, C', collectors; r, r, r', r', rails; P C, parallel conductor.

FIG. 2.—END SECTION OF TUBE.

The railways would be laid in tubes of a rectangular section, and so arranged that the down track would occupy the lower, and the up

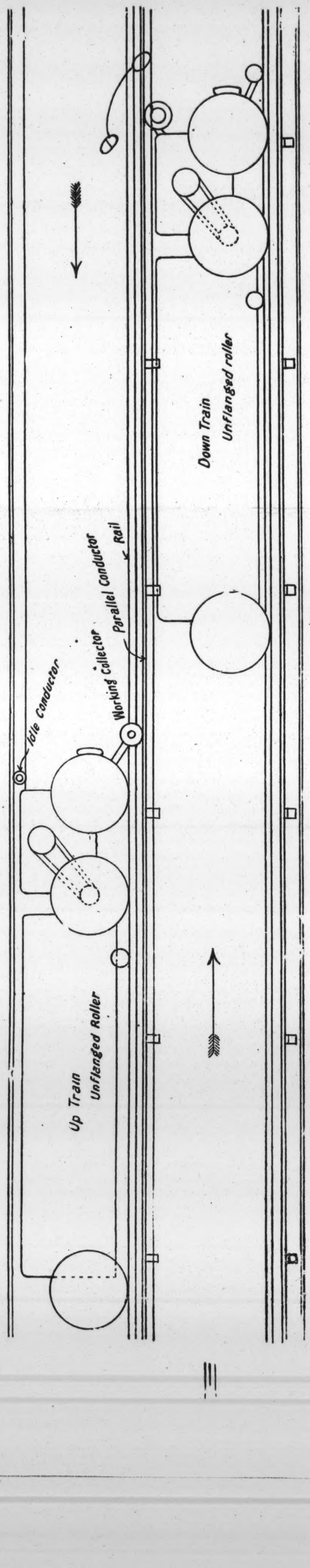


FIG 3.—SIDE SECTION OF TUBE.

track the upper, portion of the tube. To permit of examination and repairs, the tube should be large enough to allow of a man or boy creeping through, and in order to afford space for this the rails are laid, not on cross sleepers, but on brackets fastened to the walls of the tube. During idle hours the full height of the tube would thus be available for the passage of workmen. This arrangement is shown in diagram 2. In order to render the rails useful as conductors they are insulated.

On the rails would run trucks propelled by electro-motors deriving their current either from one of the rails or from a separate parallel conductor. On the down journey a truck would gather current by a collector pressing on the under, and on the up journey by one pressing against the upper, surface of this conductor, separate collectors being provided and connected to the motor in such a way that a truck could not be made to travel in the wrong direction. If on the down track, it could only obtain current through its upper collector, which would propel it always away from the central; if on the up track, its lower collector would only be operative, and this would always move it towards the central. There are several ways of attaining this end. Collisions between meeting trucks would consequently be impossible. A side section of the tube, showing passing trains, is shown in diagram 3.

The tubes may be of any size, but I have taken 2 feet wide by 3 feet high as a suitable one. This would permit of trucks 20 inches wide by 14 inches deep being used. Their length might be considerable, but it would be regulated by the radius of the curves. Supposing 48 inches were found practicable, such a truck would contain 13,440 cubic inches, and so be available for pretty large packages. In order to obtain a deep, unbroken box, it is necessary to place the wheels at the ends; and, to get as flexible a wheel base as possible, the wheels should have side play. The electro-motor is mounted on a separate carriage, and coupled to the truck, as shown in diagram 4. Only one end of a truck is supported on wheels, the other resting on the motor carriage by means of a pin which drops into an eye. Each truck would be fitted with such an eye, so that when a train consists of more than one truck, the coupling pin of each supplementary truck will drop into the eye of the next. If the wheels are given side play, a very flexible train, like that shown in the diagram, capable of traversing short curves, would result. To prevent bearing down when heavily laden, each truck may be fitted at its coupling pin end with a pair of unflanged wheels or rollers that will rest on the rails without increasing the rigid wheel base. To secure the adhesion necessary for steep gradients, the wheels of the motor may be coupled, or each pair driven by a separate belt from the motor pulleys.

The central station would be established in a suitable locality. In a large town there might be several stations, connected with each other by one or more sets of tracks, just as telephonic switch rooms are connected by junction wires. The central station would contain the engines and dynamos for generating the electricity required for working the system, and it might also be utilised as an electric light-generating station, or a telephone exchange, since the tubes laid for the parcel exchange service would serve admirably for containing and distributing conductors and wires.

At the central station a turn-table or other device for the interchange of trains between the tubes would be provided for each tube. these turn-tables would communicate with each other, either direct, or by means of a central turn-table, so that a free interchange of trains between the tubes would be secured. Each tube and turn-table would be worked by an operator. The turn-tables would be in two stages, to accommodate the down and up tracks, between which traffic would be exchanged by altering the level of the tables by means of hydraulic jacks. Diagram 5 gives a general idea of such a system. Empty or lying trucks would be stored in siding tracks, built one above the other, and reached by altering the level of the turn-tables.

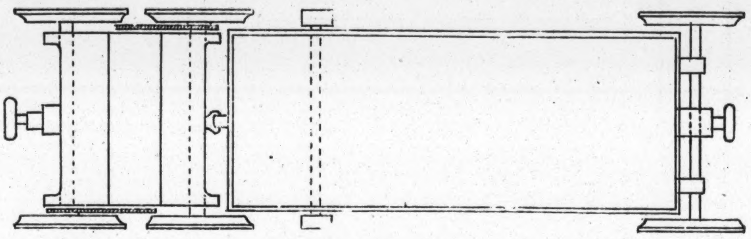
Connection with the premises of subscribers to the system would be made by short spurs or sidings diverging from the nearest main tube. At the junction of the branches with the main tracks switches similar to ordinary railway switches would be placed, and controlled by the operator at the central by means of electro-magnets. These switches may be arranged in various ways. They may be kept in position for through main line traffic by means of springs or permanent magnets, and be shifted to connect with the sidings by a current sent from the central, resuming their normal position as soon as the current ceases; or they may be wrought entirely by electricity, a current of one sign shifting, and one of the opposite sign replacing them.

The operator will, of course, require to find and work any switch with certainty and rapidity. I propose to enable him to do so by the arrangement shown in diagram 6, although several other methods, requiring fewer conductors, could be devised. One pole of a battery or dynamo is joined permanently to an outgoing conductor, which traverses the whole length of the tube. At each switch a branch is taken from this conductor, which, after passing through the electro-magnet controlling the switch, returns to the central, and is there taken through an electro-magnetic indicator, which may resemble a railway semaphore signal in appearance, and a contact maker, to the other pole of the battery. By closing any of the contact makers the operator can put over any of the siding switches, and the indicators show him that the current is passing. In the diagram, one switch is shown over and the semaphore indicating a clear road for that siding. It might be arranged to show him not only that the current is passing through the coils of the electro-magnet, but that the armature has actually been deflected, and the switch put over.

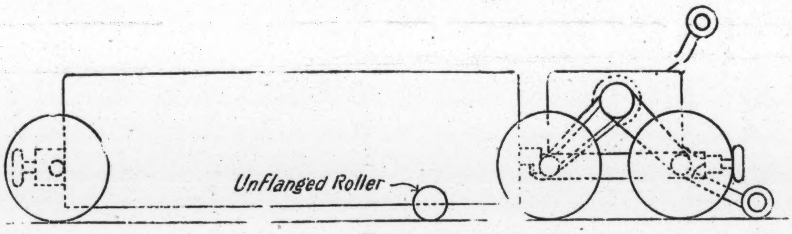
The sidings into subscribers' buildings consist of down and up tracks, one above the other, but, when space is available, these are caused to diverge after entering the building, and ultimately to meet in one track, so that trains may be shifted from the down to the up track without lifting them off the rails. Diagram 7 illustrates my meaning.

The parallel conductor on the down track need not be carried into the subscriber's building, but may be stopped short within the tube, and the train allowed to finish its journey by the momentum it has acquired. If the conductor were continued to the end of the track there would be waste of energy and danger to the motor in the event of delay in attending to a truck on its arrival.

On entering a subscriber's building, a train would have its speed reduced, and finally be brought up by the axle engaging with a hook attached to a weight or spring, or a projection on the truck could depress triggers, which would rise again after its passage and prevent any running back due to rebound or gravity. Such triggers could be electrical contacts, and be made to signal a train's arrival to any part of the subscriber's premises and to the central station. Similar stopping devices would be necessary at the central station to prevent arriving trains over-running the turn-tables. The subscriber's siding would terminate in an elastic buffer or stop-block, which would finally bring the train to a stand.



PLAN (LOOKING DOWN).



ELEVATION.

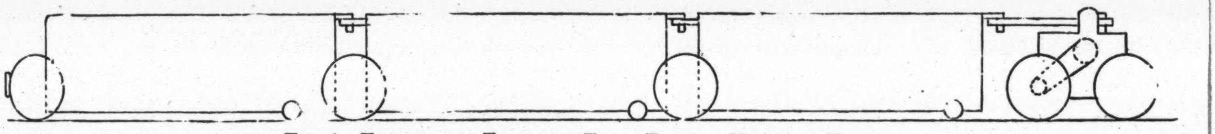


FIG. 4.—ELEVATION OF TRAIN WITH THREE TRUCKS. MOTOR AND TRUCK.

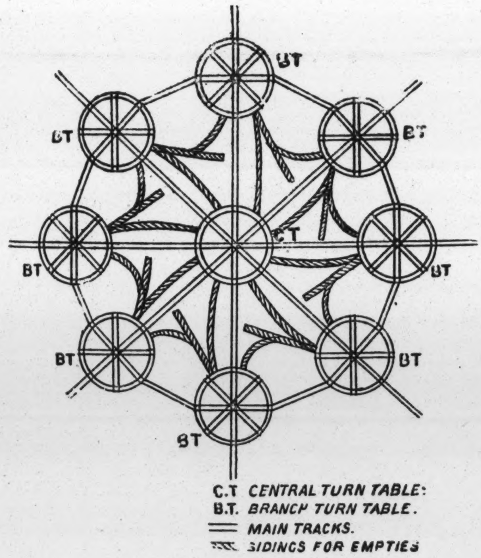
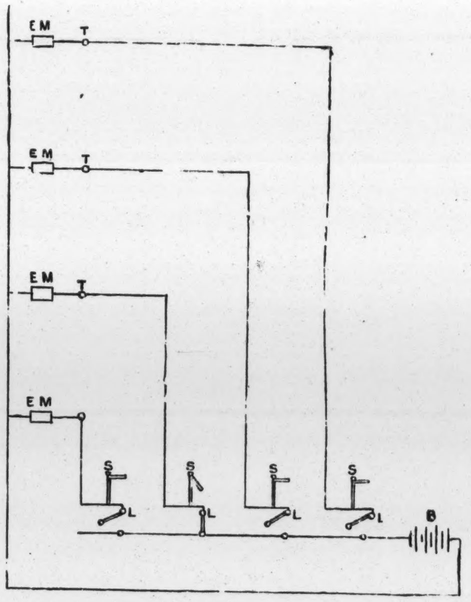


FIG. 5.

After leaving the main line, and getting well into the siding, a train could be made to break the circuit of the return conductor operating the switch by passing over one or more trigger contacts. The semaphore arm at the central would, thereupon, rise temporarily and ring a bell, notifying the operator that the train was safe in the siding, and that he might clear the switch for other traffic. Such triggers, if made workable in the down direction only, could be arranged to prevent a train running back and fouling the main line. Such trigger contacts are indicated at T in diagram 6.

In order to keep traffic circulating, it is necessary that the operator shall be able to follow the progress of all the trains in motion in his tube, so that the position of each, and of any accidental stoppage, may be known. This may be accomplished much in the same way as that proposed for operating the switches. One rail of a track is in continuous electrical contact throughout; the other is divided into insulated sections of any desired length. If a battery is permanently connected to the continuous rail, and the sections joined to its opposite pole by means of return wires, in the circuit of which electro-magnetic semaphores or other indicators are included, the progress of a train will be traceable throughout its whole journey, for, as it short-circuits the rails, the semaphore arms will successively rise to "danger" as it passes from section to section and fall to "line clear" behind it. The failure of a train to enter any siding will be revealed, as its presence on the section beyond will immediately be apparent.

Should a train, through any accident short of disrailing, stop in the tube, the semaphore of the section it is on will remain continuously at danger, and the operator will know that such a stoppage has taken place, together with its position, and take steps to remove it. For instance, he could send an empty truck forward, the speed of which could be reduced to a minimum as it approaches the disabled train, by modifying the amount of the propelling current, until it strikes against the disabled vehicle; then, full current being turned on, both trucks could be forwarded to the consignee or shunted at the next convenient siding. The owner of that siding could be requested by telephone, if so connected, or, otherwise, by a note placed in the empty truck, to couple the vehicles together and return them to the central on the up track. A stoppage



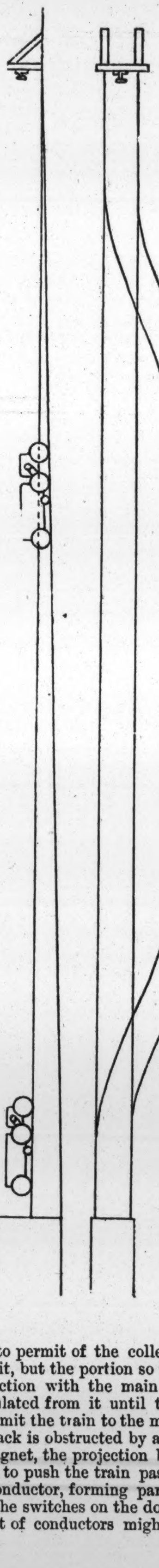
B, battery; E M, electro-magnets controlling switches; S, indicators; L, circuit closes; T, contact breakers.

FIG. 6.—ELECTRICAL CONTROL OF SUBSCRIBERS' SIDINGS (DOWN).

on the up track would be dealt with by bringing a truck out of a siding lying beyond and causing it to push the disabled one into the central.

Having explained how the down line switches are managed by the operator, I shall next describe how he can be given control of the up line ones, too, as it would never do to allow subscribers to send trains into the tube at will.

A branch from the parallel conductor carrying the propelling current is taken into the subscriber's premises on the up track for a short distance, so as to permit of the collector of at least one truck being placed against it, but the portion so taken in is not in permanent electrical connection with the main portion of the conductor, but is effectively insulated from it until the operator at the central station is ready to admit the train to the main line. At the entrance of the tube the up track is obstructed by a projection from the armature of an electro-magnet, the projection being of sufficient solidity to resist any attempt to push the train past it. The electro-magnet is in circuit with a conductor, forming part of a system resembling that which controls the switches on the down line. By using reversed currents, the same set of conductors might be made to operate the down siding switches, and these up controlling electro-magnets; in any case, the same out-going conductor would serve for both purposes. The armature of the electro-magnet, when attracted by a current from the central station, removes the obstructing projection, and completes a connection between the main parallel conductor and the portion, hitherto insulated, within the subscriber's premises. If the collector of a truck is pressing against the conductor when this takes place, the motor at once obtains current and enters the tube. The up siding joins the up main line by a switch, which, like catch-points on a railway, is opened by the wheels of the truck itself, so that after the operator has started a train, no further control is necessary until it reaches the central. As soon as the train reaches the main line, it begins to operate the up semaphores at the central, and the operator again blocks the siding.



SIDE VIEW.

FIG 7.—PLAN.

When starting a down-line train, the operator at the central places the train at the entrance of the tube, so that the collector of at least one of the motors presses against an insulated section of the propelling current conductor. If the consignee is connected by telephone or electric bell, the departure of a load for him is duly signalled, and as soon as the down line is sufficiently clear of previously-despatched trains, as indicated by the semaphores, the operator admits current to the insulated section of the conductor, and the train enters the tube. The switch of the siding it is intended for, being set, the train turns into it and signals the fact to the central by breaking contact at T, diagram 6. The operator thereupon takes off the current, and the switch resumes its normal position. The train runs into the subscriber's premises, where it is gradually brought up, and where it announces its arrival by ringing bells, or otherwise. The load is taken off, the train transferred to the up track, and when it is desired to return it to the central, either with a new lading or empty, it is placed at the entrance of the tube with the collector against the insulated section of the up propelling current conductor. The operator is advised by signal that a train is ready for despatch. When he has a clear line he works the electro-magnet, which removes the mechanical obstruction, and at the same time gives the motor current, and the train runs up to the central, where its motion is gradually arrested. If the load is consigned to the central, the operator turns the truck or train into the siding assigned for such traffic; if addressed to another subscriber, he transfers it to the down track of his own tube, if the consignee's siding is served by it; if not, he forwards it, by means of his turn-table, to the operator who works the tube it is designed for. So, when one subscriber sends a parcel to another, he despatches it, in the first instance, to the central station, where the operator re-forwards it as required.

Should a truck by mistake be delivered to the wrong siding, the subscriber has only to transfer it to the up track, and return it to the central.

Although each subscriber could advantageously be connected, telephonically or telegraphically, with the central, such a means of communication is by no means necessary. Trains, as already stated, would announce their own arrival in the subscribers' premises, and if subscribers would place trains on the up line ready for departure, the operator could withdraw them when convenient, without troubling the subscribers further. It would be easy to make a rule for the operators to tap all or particular sidings at prescribed intervals during the day, and so withdraw unannounced traffic. The subscribers could be supplied with empties during the night or slack hours of the day without any attendance on their part. Automatic working could be carried further still, for it would not be difficult to arrange to unload trucks sent into subscribers' buildings, and afterwards withdraw them as empties, without any personal attention. The loads could be tilted off, and the truck, when clear of the down-propelling current, run down an incline and through cross-over points to the up track, where it would find the up-propelling current, and immediately commence its return journey to the central. Thus a man's coal cellar might be filled in the night by a succession of such automatic trucks.

If desired, the starting levers at the central could be interlocked with the levers controlling the siding switches, so that a following train could not leave until the switch set for the preceding one had been restored to its normal position. Collisions between following trains could be prevented by an automatic block, such as was devised by Jenkin and Elliott and Ayrton and Perry for telpherways, by which the second train loses its propelling current if it approaches the preceding one too closely. These precautions would, however, tend to restrict the capacity for traffic, and, as collisions would not endanger life, I am inclined to think that strongly-built trucks, with good elastic buffers, and, perhaps, extra deep flanges to the wheels, to prevent disrailing, would constitute sufficient safeguards against damage to goods arising from an occasional collision. The operators would not allow two trains on the same section simultaneously, and, if the sections are 100 yards in length, I contemplate the possibility of a pair of skilful operators, one for the down, the other for the up track, keeping 34 trains circulating in a tube a mile in length—17 down and 17 up. The various control movements are but momentary, and they would only have to be timed in accordance with the indications of the semaphores. At 8 miles an hour, 17 sections to the mile would give nearly half a minute between each train.

The body of the tube, if of metal, could constitute the return for the propelling current. For signalling the progress of trains, one rail of each track might form the outgoing conductor, while the returns could consist of small wires—No. 18 gauge would be ample—made up into cables. One outgoing conductor of No. 12 gauge could carry all current for operating the siding switches and block electro-magnets, the returns being No. 18's cabled. The number of conductors would dwindle as the distance from the central increased, and as they would be small and cheap, the outlay for them would not be considerable. Of course, the various switches and semaphores might also be worked off the parallel conductor supplying the motors, as shown in diagram 3.

For inspection and repairs a special form of truck, or platform, on which a man could crouch or lie, would be provided. The motors of these would be under the control of the men using them, and they would be fitted with brakes, incandescent lamps, and telephones for communicating with the central.

Although the proposal for a system of this nature may appear a little startling, its details, as I have sketched them, comprise no device that has not been thoroughly tested in the telegraph and signalling departments of the Post Office and railway companies, or in connection with electric traction. Mr. Preece, many years ago, employed electro-magnetic semaphores, such as I propose. The shifting of switches and blocking by electro-magnets has been rendered familiar by the labours of Spagnoletti, while the picking up of current has often been demonstrated, notably on the City and South London Electric Railway. It may, consequently, be confidently asserted that the plan would work, and work well.

Whether such a system would pay is another matter. If constructed specially and solely for parcel work, probably it would not, although the surprising developments of the last decade scarcely justify us in assigning limits to the possible developments of the next; but I assume that the construction of subways beneath all the chief thoroughfares of large towns, for the purpose of containing electric light and power leads, telephone wires, pipes for gas, water, fresh and salt, hydraulic and pneumatic tubes, and, perhaps, oxygen or ozone to supply our homes with mountain air; together with other possible adjuncts of our complex civilisation, will shortly become an absolute necessity. A beginning in that direction has already been made by limited companies in some of the American towns, and we must sooner or later follow suit. Then, when that time arrives, an electrical parcel exchange could be carried out economically and effectively as part of the scheme. I look forward to a time when our foot-paths and carriage-ways will be laid upon the lids of huge boxes through which, perhaps, in addition to the various fittings already named, will be carried well-lighted footways affording crossings and short cuts for passengers at congested spots.

Supposing, for the sake of argument, that the scheme is financially practicable, its many uses will, I think, be readily admitted. What an aid it would be, for instance, to the postal service were St. Martin's-le-Grand connected by such tubes with the principal post offices in the City and West End. The telegraphic department at present derives great assistance from pneumatic tubes, an inch or so in diameter, through which crumpled-up telegrams are forced in India-rubber balls. If letters and parcels could be interchanged in a similar manner, deliveries could be expedited and multiplied, and the capacity of the department generally increased. Parcel post hampers could be despatched to, and received from, the great railway stations in a minute or two, and the mails of subscribers to the exchange system could be delivered without the aid of postmen, while such subscribers would be able to despatch letters and parcels, together with telegrams and the money to pay the charges thereon, straight to the chief post office, so saving labour and delay at the branches. Such a system would form the first step towards telegraphing, or rather wiring, matter.

Apart from the Post Office, many uses suggest themselves. Parcel receiving offices and great despatches of small packages, like the Co-operative Stores, Whiteley and others, would find direct connection to the railway stations, and with other business houses, an important boon. Buyers could telephone for samples and patterns of all kinds and obtain them almost immediately. Hotels and restaurants could telephone for, and receive, in a few minutes, supplies they may run short of, and enable their customers to choose wine, not only from the cellars of the establishment, but from those of every wine merchant on the system. Cooks at private houses could not only telephone for a leg of mutton, but have it ringing a bell in the course of a minute or two to announce its arrival. The story of the doctor prescribing by telephone for a baby whose cough he had listened to by the same means is well known. A friend of mine suggests that, with the parcel exchange system, the mother could improve on that by sending the baby bodily to the doctor, *viâ* the central station, and receiving it back with a bottle of medicine in its fist and a mustard leaf on its chest.

DISCUSSION.

Sir F. **BRAMWELL** said it appeared to him that the author had very well thought out his subject. Means were provided for overcoming difficulties, and in particular he was extremely pleased with the method employed for overcoming the difficulty of return traffic. In this respect electricity lends itself better than air to such traffic, because trains can go in opposite directions in the same tube, and also because of the greater facilities for repairs. Sir Frederick agreed with the writer of the paper that there was nothing proposed in it which is not already in one way or another in operation, and therefore one may safely expect that the system would work. He would like to see it tried, because it had been so well thought out.

Mr. **GREATHEAD** did not consider the subject quite so simple a matter as the author thought, because electrical apparatus will fail. In London there were an immense number of pipes laid, and also the cellars of houses to avoid. The position of the tubes would have to be about the level of the bases of the buildings, and they would occupy a space 4 feet high, and from side to side of the street, to allow of connections to the houses; hence, he thought, they would not be allowed in London. Moreover, he thought the cost would be large and consequently the system would be non-paying.

Mr. **BINNIE** admired the ingenuity with which the author had worked out the details. He feared there were great difficulties in applying such a system. There were 12 miles of subways in the metropolis, to accommodate gas, water, telephone and telegraph wires, and he foresaw difficulty in the use of lateral branches. The subsoil was already occupied, and the expense would be very great.

Mr. **BENNETT**, in reply, said he had anticipated fully the difficulties. There was a time coming for removing existing complications by making a clean sweep and commencing over again. The Post Office may probably be looked to for the initiatory movement in this direction. He foreshadowed an electrical parcel post, and claimed that the work at branch post offices could be economised or saved by letters, &c., being brought automatically to the General Post Office.

The **CHAIRMAN** thought the scheme quite feasible and likely.

ON THE TELEPHONING OF GREAT CITIES.

BY A. R. BENNETT, M.I.E.E.

(*Read before Section G, August 24th*, 1891.)

A MATTER which has never yet been seriously faced is how the demand for telephonic exchange connection, which, after the lapse of a few more years, is bound to arise in all large cities, is to be met. As yet, the merest fringe of telephony as it will ultimately be when developed has been touched. A time will come when every shopkeeper, and almost every householder, will require his telephonic exchange connection.

What is possible in this direction under the influence of moderate rates and a reasonably efficient service has already been demonstrated in certain localities, chiefly in Scotland, where towns boasting of next to no manufactures or staple trade possess exchanges far exceeding in importance those of many English towns of three and four times the population, the principal supporters of such exchanges, after the manufacturers and merchants, being professional men, as doctors, solicitors, and accountants; householders; and shopkeepers, as grocers, butchers, and druggists.

As exchanges so composed continue to exist and increase year after year, it may fairly be assumed that the subscribers get back their rentals in some form or another, and it may likewise be argued that what is profitable north of the Tweed would be found equally so south, if the experiment were only tried—as it certainly will be some day.

Then, when that time arrives, and the householders and shopkeepers of London follow the example of, say, those in Galashiels, and come to regard a telephonic exchange connection as necessary to their business as the laying on of water or of gas, a problem will present itself which, although not entirely free from difficulty, will not, in the light of past experience, present any insuperable obstacles.

The efficiency and the readiness with which a large town or city can be telephoned so as to meet the ever-increasing demands of the inhabitants will depend, in a very great measure, on how the work is laid out and set about in the initiatory stage.

If London were telephoned in the same proportion as Galashiels, it would possess 28,000 subscribers, but that number does not nearly represent the possibilities—far from it. When a city has attained to the size of a nation—for is not London a nation in itself?—it behoves us to look forward. We must certainly anticipate one telephonic exchange connection for every 50 inhabitants in London in time to come; a modest estimate, if we consider that there is already one for every 200 inhabitants in Galashiels and some other towns, which are the merest hamlets in comparison—places in which a pistol shot will carry from the centre to the green fields in any direction. With London's present population of 5,600,000 such a proportion would represent 112,000 subscribers, and, as the population increases and the boundaries extend, more and more will grow the demand, until even that great number will appear inadequate and insignificant.

Every villa in the residential districts, every suburban shopkeeper, will be on the exchange, and the telephone will supersede in London, as it has already done elsewhere, the butcher's boy, the grocer's lad, and the baker's man—at least, so far as the daily calling for orders is concerned—and tend to make us more independent than we are at present of the domestic servant.

As the new generation grows—a generation familiarised from its cradle with the word "telephone" and the idea of conversing at a distance with all and sundry, and consequently free from the prejudices and old-fashioned methods which have, in very many cases, deterred their fathers from availing themselves of the new agent—every young man starting in business will order a telephone connection at the same time that he orders his fuel, light, and water, just as a matter of course; and, if time is found at all for speculation on such a commonplace subject, it will be devoted to wondering how his steady-going progenitors did without it.

As an indication of how the telephone idea is taking root, I may mention that the builders of a new block of business offices in Manchester propose to put a permanent connection to the Mutual Telephone Company's exchange into each suite of offices, paying the subscriptions themselves, and charging their tenants nothing extra. This is one of the first-fruits of cheap rates.

The possible demand being conceded, the question arises, "Can it be met; and, if so, how?"

I answer that it can, and I propose to show how.

The establishment of an effective and popular telephone exchange in a large town, and one that can be added to and extended freely and economically, without pulling down what has already been done, involves the fulfilment of several indispensable conditions.

Firstly.—Speech must be loud and distinct, and privacy of communication complete; and a subscriber's line and apparatus must be adapted equally well to speaking to another across the street or to one 500 miles away. There must, furthermore, be an absence of all disturbing sounds.

Secondly.—The arrangements for connecting the subscribers together, subsequently disconnecting them, and, if required, immediately re-connecting them to others, must be so complete that eight or ten seconds should be the maximum time occupied within the compass of the largest town.

Thirdly.—The rates must be within the reach of even small householders and shopkeepers, and should not exceed £8 per annum.

Fourthly.—The general design must permit of the addition of new subscribers in every direction and to any extent, without interfering with the work already done.

All these conditions can be complied with. What is necessary to do to meet them can be broadly indicated under three headings.

1. The universal use of metallic circuits, and the absence from the line of intermediate electro-magnets and other signalling devices, which tend to damp and deform the electrical vibrations which constitute telephonic speech.

2. The provision of means by which certain and instantaneous communication can be established between subscriber and operator, and between one operator and another.

3. The division of the town to be telephoned into districts or sections not exceeding a square mile in area, each of which is worked from a switch-room placed at or near its centre.

The fulfilment of these necessary conditions is easy, provided the undertakers, whomsoever they may be, are in possession of the right to open the streets of the town and lay their conductors in the same way as gas, water, electric light, and, in some instances, hydraulic and pneumatic power conductors, are laid.

So long as the execution of any scheme is subject to the caprice or the blackmailing propensities of individual proprietors, a proper telephonic service, such as London, the first city of the world, ought to possess, will remain an aspiration and nothing more. It has always been a bugbear of telephonists in this country that they have to fix their wires, not where they want them, but where they are permitted to. A British telephone exchange system is consequently, generally speaking, the result of a constant endeavour to reconcile the desirable with the impracticable—a compromise rarely, if ever, satisfactory.

Legislative assistance to the extent of placing the undertakers of telephone exchange systems on an equal footing with the ministers to other public wants is indispensable to the carrying out of a scheme designed, not only to meet the requirements of the moment, but those of a reasonable number of years to come.

I am not one of those who believe that there is no design in the conduct of the universe—that railways and steamboats are because they happened to have happened, or because Newcomen, Trevithick, Watt, Stephenson, and Symington chanced to have ideas—that telegraphs are because Gauss and Weber, Cooke and Wheatstone, and Morse, were scientific enthusiasts—that telephones are because Reiss, Varley, Bell, Edison, and Hughes were covetous of fame, fortune, or notoriety.

No! Railways and steamers, telegraphs and telephones, are means adopted by the Great Designer to meet the needs of growing populations—to render possible the feeding and clothing of the ever-increasing millions—to lay under contribution for their benefit the uttermost parts of the earth. They make the world larger by increasing its capacity for population, and, at the same time, smaller by quickening communication. The means at the command of our fathers a hundred years ago would not suffice to feed the populace of to-day. Famine and pestilence, without such beneficent provisions, would have kept back the multiplication of the human race; a certain stage would have been reached, but, without the new appliances, never passed. The process is still going on, and will not stop at telephones we may be sure. The future has greater wonders in store than any we have so far seen. Some are already casting intermittent scintillations of their brilliance before—just as telegraphs and telephones were talked of ages ago. It has been truly said that the dreams and fairy tales of one generation become the every-day commonplaces of the next.

Starting with the admission that the telephone is neither a fad nor a luxury, but a providential provision for man's use and benefit—a practical, earnest, matter-of-fact instrument, which has come to stay—we may likewise assume that it is not possible to stifle it, to relegate it to oblivion, or even to curtail its natural extension. Sooner or later it will be universally recognised that the general use of the telephone has to be provided for, and the legislative sanction I am now advocating will be granted in order that such an excellent servant may be turned to the best account.

Without such legislative assistance, which, I contend, cannot consistently be withheld, seeing that it is granted as a matter of course to railway, tramway, and other companies, the efficient and economical telephoning of great cities verges so near to the impossible that, during the remainder of my paper, I shall assume that it will be forthcoming at the proper time.

As already indicated, the system of the future for all large towns must be founded upon the use of multiple switch-rooms, each serving its own immediate neighbourhood.

All the subscribers' lines will then be short and economical to construct, while the switching apparatus, owing to sub-division, will be simple and cheap. These conditions will enable the annual payments by subscribers to be kept down to a minimum.

All subscribers' lines will be metallic circuits. To the British Post Office (in the person of Mr. W. H. Preece) belongs the honour of being the first to insist on the necessity of double wires for telephone exchanges. The Post Office exchanges have always been constructed on that plan, and, until a few months ago, they were singular in that respect, and the only ones in Great Britain to which a British technical man could refer with any gratification. Some of the National Telephone Company's exchanges have not been without merit, but being single wire ones, their foundations were as quicksand, and no amount of ingenuity expended on superstructures could compensate for such a radical defect. At best, the faults inherent in the system could be palliated, not cured.

So long ago as 1883 I warned the National Telephone Company of the error they were committing in persisting in the use of the single-wire system, and pointed out how it was then possible to change gradually and economically to metallic circuits. The opportunity was lost, and now cannot be regained without sacrificing the greater part of the capital they have expended.

When the Mutual Telephone Company started in Manchester I advised them to have nothing to do with single wires, but to secure privacy and freedom from disturbing noises by using nothing but metallic circuits. The advice was taken, and universal commendation has resulted.

To obtain an efficient service with multiple switch-rooms by the aid of the switching apparatus ordinarily used in this country, with its intermediate electro-magnets and numerous complications, would be out of the question. A radical departure from existing practice must be made in this, as in other particulars. Fortunately, the way out of the difficulty lies ready to our hand.

For a good many years now a system known as the "Mann" has been operated with the greatest possible success in several districts, principally in Scotland. This system is unrivalled in many respects. It enables connections to be obtained with certainty and celerity; it renders easy the task—on some of the older exchanges an arduous and frequently impossible one—of getting rid of one connection and obtaining another. It simplifies and cheapens switching apparatus to an almost incredible degree, and it permits of connections being made through many switch-rooms without the intervention of intermediate electro-magnets, so that no retardation and indistinctness of speech results. The system possesses other conspicuous merits, but it is unnecessary to enlarge on them here.

In one respect, and in one only, is the "Mann" system apparently more complicated and more expensive to instal than the ordinary. It necessitates the taking into each subscriber's office of a branch from a common service wire, on which all communications with the operators are conducted, and the addition to each subscriber's instrument of an extra piece of apparatus.

But the complication is more imaginary than real, while the extra cost of the service wire and fittings is saved many times over in the switch-room, where an infinity of complicated and expensive apparatus is dispensed with, and where faults, and attendance by skilled electricians, are reduced to a minimum.

The main feature of the system is the service wire already mentioned. One such wire is allotted to every 60 to 100 subscribers, according to the amount of traffic passing. During the busy hours of the day operators are always listening on the service wires, so that subscribers may speak and be heard without any premonitory signals. By means of specially constructed telephones, weighing but a little over 2 ounces, attached to the head by springs, the girls are enabled to listen continuously without fatigue, and at the same time keep both hands free for operating purposes. The subscriber, on his part, can at any moment place himself in communication with the operator by depressing a small lever, which has the effect of changing his instrument temporarily from his main line to the service wire.

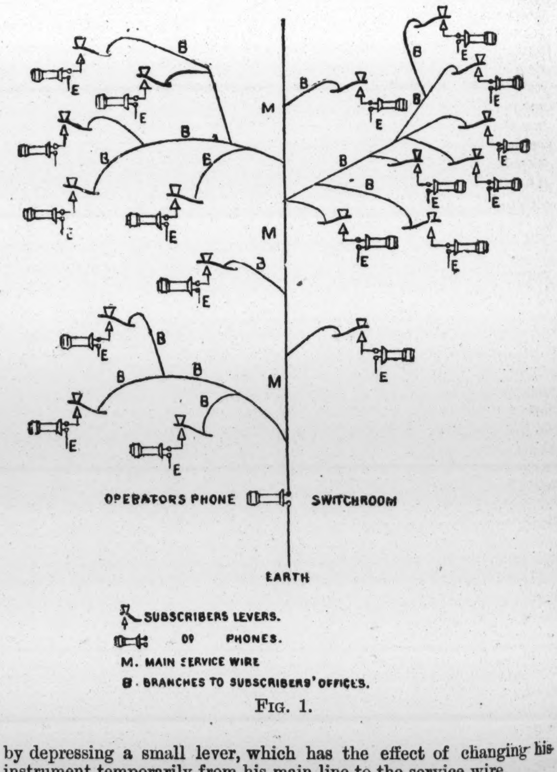


Fig. 1.

The mere depression of the lever suffices to secure her attention at any moment, so that mistakes can immediately be rectified and an explanation asked of any delay. The operators have not to do any ringing at the exchange, the subscribers working their own call bells, thus leaving the girls to perform only the acts of connecting and disconnecting, a feature which greatly contributes to the rapidity for which the system is famed. A deal of labour is also saved by the absence of the ordinary shutter indicators, the putting up of which, after they have been dropped by the subscribers, constitutes a large part of the operator's work with other systems. The general plan of the service wire is shown in diagram 1. The operator's phone is always earthed; those of the subscribers only when their levers are depressed.

During the night and slack hours the operators do not listen continually, but the depressing of the subscriber's lever makes a signal which the operator can respond to so quickly that she is ready to listen as soon as the subscriber is to speak.

The marked superiority which this system had shown over every other in Scotland during the years 1883—90, induced the Mutual Telephone Company to adopt it for their Manchester Exchange. It was accordingly introduced there in February last, and has already established itself firmly as the best in the estimation of the subscribers.

The experience gained at Manchester has enabled the one objection to the "Mann" system—the necessity of taking an additional wire into each subscriber's office—to be overcome.

After having designed and partially constructed the Manchester Mutual Exchange on the "Mann" system, it occurred to me that it might be possible to convey the service messages between subscribers and operators by means of electrostatic induction between the subscriber's metallic loop and a special single wire run out for a sufficient distance from the Exchange amongst each group of metallic circuits.

On arranging the wires and apparatus in the manner indicated in diagram 4, it was found that such a plan was really practicable. The connections of the subscriber's instrument were altered in such a way that, on depressing the lever, the metallic circuit (represented by M in the diagram) was put to earth through the telephone. The metallic circuit then acted as a single wire of double area, and, whether insulated at the switchboard or connected through to another circuit, practically formed one plate of a condenser, the other plate or plates of which were any of the adjacent wires that happened to be earthed at their extremities.

It was therefore only necessary to put the operator's instrument in permanent connection with one or more wires running parallel to the subscribers metallic circuit for a short distance, to enable any of the subscribers, whose instruments were so fitted, to communicate with the operator by depressing their levers. When the levers were not depressed, the telephones were looped in the metallic circuits as usual, and the operators could neither hear nor be heard.

When cables were used containing 36, or even 72 metallic circuits, it was only necessary to connect the operator's phone to a single wire placed in the centre of the cable, or to the metallic sheathing of the cable, to obtain perfectly good speaking when the metallic loops were earthed by the subscribers depressing their levers.

When a connection has to be obtained through more than one switch-room, it is asked for by each operator in succession, by depressing a lever, which puts her in communication with a service wire on which the operator at the next switch-room is listening. (Diagram 5.)

The phenomenon utilised for so conveying the service messages is the one which, under the name of induction, has always been the bane of telephonists, and I believe it has never been turned to any useful account before.

With this plan it becomes unnecessary to take a separate service wire into each subscriber's office, thereby saving expense, and permitting of thinner leads being employed.

I have recently devoted considerable thought to the problem of telephoning a great city like London.

I have taken as a groundwork an area of 32 square miles, measureing eight from W. to E., and four from N. to S. Such an area would comprise the greater part of London, from Shepherd's Bush to Limehouse, and from Primrose Hill to Kennington Oval, and include the chief of the telephonic wealth of the metropolis. Such portions as lie beyond are comparatively poor, and can be dealt with readily by special offshoots from the main system.

Comprising, as it does, the heart of London, such an area would contain the whole, suburbs and all, of any other city in the world. My remarks apply, therefore, to any large town, and the scheme curtailed will fit any town smaller than London.

In considering my plan, I have kept steadily in view the conditions I have stated to be indispensable, putting efficiency first and economy second, although, as it happens, I have found the two march well together; so that the working out of my plan, especially if permission to place wires underground is obtained, will be found quite compatible with earning a good dividend on £8 rates. With the Mutual system vanishes the whole costly and complicated paraphernalia of American switch-room apparatus which has been so blindly copied in this country. As an instance of the economy effected, I may mention that in a switch-room fitted for 5,000 subscribers, the first cost per subscriber on the American plan is about £3 10s. for switching apparatus alone; on the Mutual plan, adopted at Manchester, the cost per subscriber is about 10s. The difference in cost of maintenance is even more striking, while the efficiency is altogether in favour of the cheaper method.

On the American plan each 100 subscribers occupy 9·9 square feet on the switchboard; on the Mutual plan, the space required for 100 is exactly 5¼ inches square. An American switchboard for 5,000 subscribers is 162·5 feet long, and it occupies 325 square feet of floor space. A Mutual board of the same capacity is 44 feet 10½ inches long, and occupies 104·7 square feet of floor space. A Mutual board, consequently, costs about one-seventh, and occupies less than one-third of the space of an American. The matter of privacy has been so specially studied, that with the Mutual switchboard the operators cannot "tap," that is, listen to conversation between subscribers, an operation which, with American boards, can be performed continually and continuously without the subscribers being any the wiser.

As already indicated, I propose to telephone any large town by dividing it into sections about a square mile in area. It will not be possible to adhere rigidly to such a division in practice, as parks, rivers, and open spaces will often intervene, and in very active commercial quarters, like the City of London, smaller sections (perhaps as many as four to the square mile) would no doubt be found desirable; but an approximation to the plan will always be possible, and allowances such as these can be made without departing from the principle.

In the centre of each square I would place a switch room, making 32 sectional or branch switch-rooms in an area of 32 square miles.

According to the configuration and general requirements of the town, I would establish one central switch-room, as in diagram 2; or two such rooms, as in diagram 3.

This would give 33 or 34 switch rooms, as the case may be, for the town.

The subscribers in each section would be connected, each by a metallic circuit, to their appropriate switch-room, and the sectional switch-rooms would, in their turn, be connected to the central rooms by as many metallic circuits as the traffic passing through them may be found to require. These metallic circuits, joining the sectional switch-rooms to the central, I call junctions. When two centrals are used, as in diagram 3, they are connected together by additional junctions. In addition to the junctions, there would be, between the switch-rooms, a sufficient number of service wires, that is to say, metallic circuits reserved entirely for service communications between the operators.

The mode of operation may be either the "Mann" plan pure and simple, or the modification of it which I have described. The latter would be the more economical, as it saves a wire to each subscriber.

At the sectional switch-rooms, operators would always, during busy hours, be listening on the service wires for orders from subscribers, or from the central; at the central, operators would similarly be listening for orders from the sectional operators.

The subscribers' lines could be distinguished, as is usual, by numbers, each sectional switch room having assigned to it 5,000 numbers, the first room having numbers 1 to 5,000; the second, numbers 5,001 to 10,000; so on to the thirty-second, which would accommodate numbers 155,001 to 160,000. This would give a skeleton list more than sufficient for one telephone to fifty inhabitants, and would take a good many years to fill up. Further expansion than this we may safely leave to our children to deal with, but the placing of new switch-rooms midway between the old suggests itself as an appropriate method of meeting any demand in excess of the capacity of the square mile scheme. Subscribers object most strenuously to any change in the number they have been accustomed to, and the necessity of making such changes can only be provided against by adopting a comprehensive scheme to begin with. The use of very high numbers could be avoided by assigning each switch-room a distinguishing name or code word, and numbering its subscribers from one upwards.

The junctions between switch-rooms would also be known by numbers prefixed by a name, or code word, which should preferably be of one, or at most two, syllables, since it would have to be repeated thousands of times a day, and indicate the locality of the section—such as Chelsea, 1, 2, 3, &c.; Tower, 1, 2, 3, &c. Sections that cannot be indicated well in a short word may be known by the names of colours—red, blue, &c.

The central switch-room need not be exclusively reserved for operating junctions. It would probably be found advantageous to connect direct to it subscribers in its immediate vicinity, and for these a separate switchboard could be provided.

The work required to obtain a connection would depend on the locality of the calling and called subscribers, and, while in every case extremely expeditious, would be more so in some cases than in others.

There would be three classes of calls:—

Class I.

From a subscriber to another situated in the same square mile section and connected to the same room.

The work would consist in the caller depressing his lever and repeating to the operator (who would be always listening) his own number and that of the man wanted, as "20 on 400." With this class of call connection should be effected in two seconds, and a smart operator would manage it in one.

Class II.

From a subscriber on any sectional room to one joined direct to the central.

In this case, the caller would depress his lever and say to the listening operator, "20 on 6,400." The sectional operator immediately depresses a lever, which puts her in connection with a second operator listening at the central, and says, "6,400, Blue 12," Blue 12 being a junction between her board and the central which she sees at a glance to be disengaged. While speaking she would peg No. 20 through to Blue 12. The central operator, on receiving the message, would know that she was required to connect subscriber No. 6,400 to her end of junction Blue 12, an operation which she can perform in one second. Such a connection should be got through in six seconds at the outside.

Class III.

From a subscriber on any sectional switch-room to one on any other.

This requires an additional repetition. The caller depresses his lever and says to his sectional operator, "6,200 on 19,406;" the operator repeats the latter number to the central, adding the name of an unoccupied junction, as "19,406, Willesden 2," at the same time making the necessary connection on the board. The central operator in her turn depresses a lever which puts her on to a listening operator at the sectional room to which No. 19,406 is connected and repeats the number with the name of a junction to that room which she sees to be free, as "19,406, Richmond 23," which junction she simultaneously joins to "Willesden 2." The Richmond sectional operator pegs No. 19,406 on to junction 23, and the connection is through. The average time occupied should not exceed 10 seconds, and in practice will frequently be less. This estimate is based on the tests described in the Appendix, which were especially designed to ascertain the average time occupied with connections coming under this third class, that is, those requiring the co-operation of three operators. I am so satisfied as to the accuracy of these and many other tests, that I should be prepared to guarantee a ten-second service between the most distant sections of an area as large as London, if telephoned as described. Experienced operators will dispense with much of the speaking. Thus, they agree to work the junctions connecting their respective exchanges in rotation, beginning with No. 1. They remember which they used last, so find it unnecessary to mention a number when asking a connection, both taking the next as a matter of course. They know each other's voices, so that it is superfluous to mention the sectional name. Thus, the last connection would be got through frequently in this way:—

Subscriber to 1st operator	"6,200 on 19,406,"
1st operator to 2nd operator... ...	"19,406."
2nd operator to 3rd operator ...	"19,406,"

all the rest being understood.

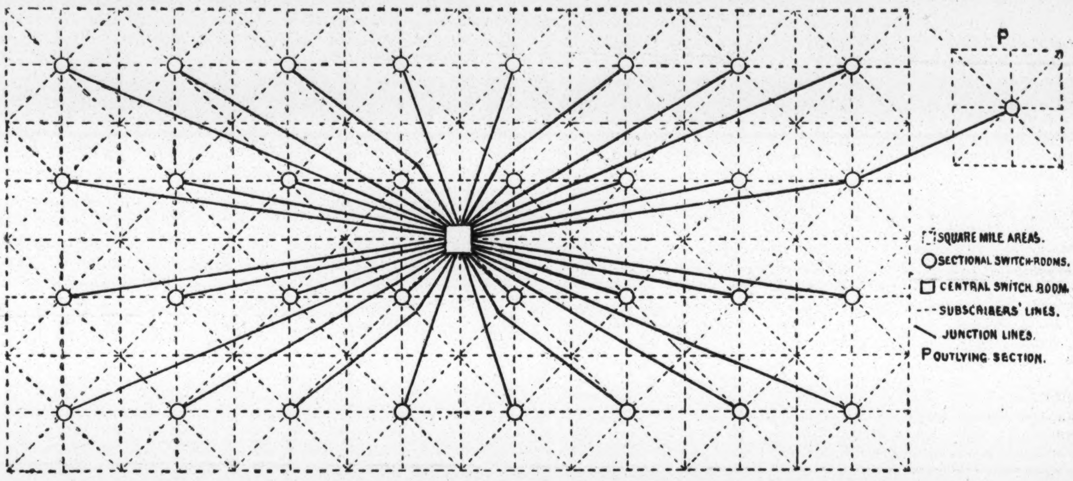


FIG. 2.—PLAN OF TOWN WITH ONE CENTRAL.

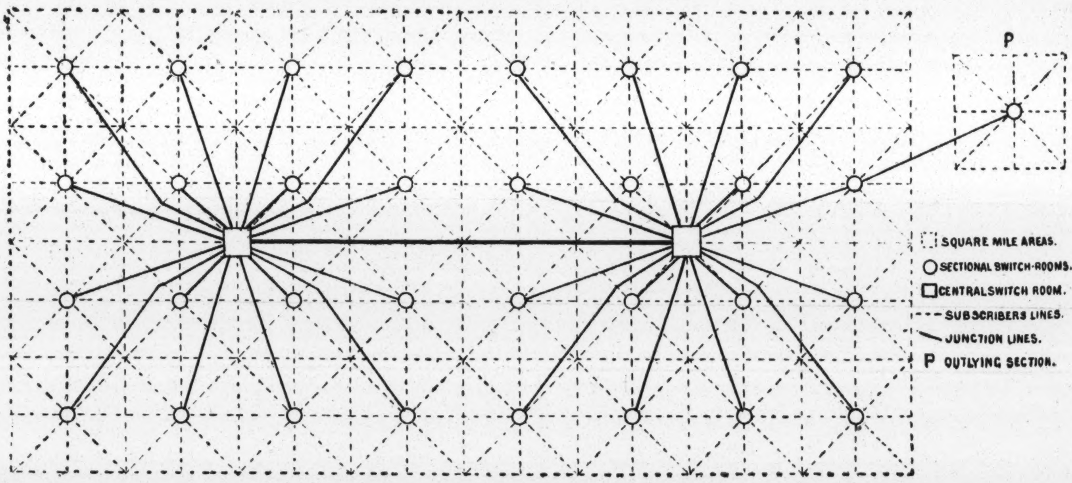


FIG. 3.—PLAN OF TOWN WITH TWO CENTRALS.

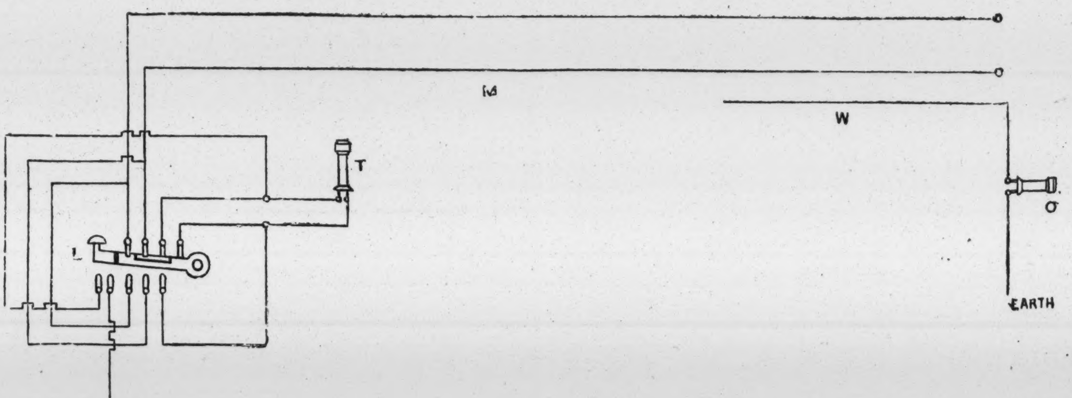
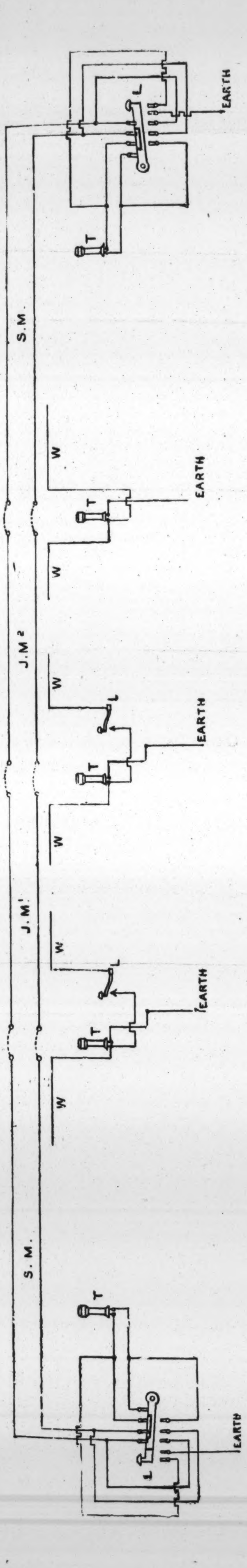


FIG. 4.

M, Subscriber's metallic circuit forming when lever is depressed the subscriber's side of the condenser; L, subscriber's lever changing his phone from metallic circuit to earth; T, subscriber's phone; W, insulated wire forming operator's side of the condenser; O, operator's phone.

FIG 5.



Calling Subscriber.
L, Lever.
T, Phone.
S, M, Subscriber's Metallic Circuit.

First Switch Room.
W, Operator's Wire.
L, " Lever.
T, " Phone.
J, M¹, Junction Metallic Circuit to Second Switch Room.
--- Switch Cords.

Second Switch Room.
W, Operator's Wire.
L, " Lever.
T, " Phone.
J, M², Junction Metallic Circuit to Third Switch Room.
--- Switch Cords.

Third Switch Room.
W, Operator's Wire.
T, " Phone.
-- Switch Cord.

Called Subscriber.
L, Lever.
T, Phone.
, M, Subscriber's Metallic Circuit.

The skill often attained by a girl who begins switching at the age of 13 or 14 is perfectly marvellous. When listening on the service wire, some of them can comprehend and execute without mistake two distinct orders spoken simultaneously by different subscribers. When a subscriber gives an order in the usual formula of "No. So-and-so and So-and-so," the girl frequently inserts the first switch-plug in the hole corresponding to the first number before the second has been spoken, and the connection is completed by the insertion of the second plug almost before the subscriber has ceased to speak, and certainly before he has time to take his finger off the service lever.

On finishing their conversation the two subscribers depress their levers, and, giving their respective numbers, say "off," as "6,200 off," and "19,406 off." On hearing, the sectional operators remove the connecting pegs and free both the subscribers' lines and the junctions for further connections. The sectional operators could also give the word "off" to the central, thus "Willesden 2, off," and "Richmond 23, off," but this would only be necessary when so busy that the demand for junctions is in excess of the supply, which would never be the case on a well-managed exchange. It usually suffices if the sectional operator in a spare moment notices which of her junctions are still engaged, and says to the central, "All off but So-and-so and So-and-so."

Districts lying beyond the 32 square mile area, in which it may be necessary to open rooms, can be attached to the general system and served as rapidly as any of the home sections. Such an outlying square is shown in diagram 2. As in all the others, an operator will always be listening for subscribers' orders, and there will be junctions, together with service wires, to the nearest switch-room within the home area. The service wires will be joined permanently to the service wires from the home sectional switch-room to the central, so that on the outlying operator asking a connection from either the sectional operator or the central, she will be heard by both. If the connection is one with which the sectional girl can deal, the central takes no notice. If, on the other hand, the subscriber wanted must be had through the central, the operator there will give the connection on a junction, which the sectional operator will indicate by a word, as it were, *en passant*. Thus, the calling subscriber depresses his lever and says, "24,002 on 15,008." The outlying operator depresses a lever which connects her to both the home sectional and the central operators, and says, "15,008, Ilford 4." The home sectional girl adds, "Stratford 19," and the central girl knows that she has to give subscriber No. 15,008 on junction Stratford 19, to which the sectional operator has already joined Ilford 4, on which the outlying operator has put subscriber 24,002. The whole can easily be managed in 10 seconds.

An analysis of the movements required to complete a connection by the Mutual, as compared with the American system, brings out the merits of the former very strongly, and sufficiently accounts for its superior rapidity.

AMERICAN SYSTEM.	MUTUAL COMPANY'S SYSTEM.
Through One Switch-room.	*Through One Switch-room.* Corresponding to Class I.
1. On seeing drop fall, operator turns down table key. 2. Plugs into caller's jack and speaks, 3. Tests line of called subscriber and, finding it free, 4. Inserts plug. 5. Depresses ringing key to signal called subscriber. 6. Replaces table key. 7. Replaces fallen shutter. 8. On receiving ring-off signal, removes plugs. 9. Replaces ring-off shutter.	1. On receiving caller's order through telephone (always to her ear), operator tests called subscriber's line and, finding it free, 2. Inserts plugs. 3. On receiving the word "off," removes plugs.
Total 9.	Total 3.
Through Two Switch-rooms.	*Through Two Switch-rooms.*
The number of movements would be double that for one switch-room, or 18.	1A. Operator A receives caller's order and inserts plugs in a junction she sees to be free. 2A. Depresses key and repeats order to operator B, 3. Who tests called subscriber's line, and, finding it free, 4. Inserts plugs, 5. On receiving "off," operator A removes her plugs. 6. Operator B does likewise.
Total 18.	Total 6.
Through Three Switch-rooms.	*Through Three Switch-rooms.* Corresponding to Class III.
The number of movements would be thrice that for one switch-room, or 27.	1A. Operator A receives caller's order, and inserts plugs, using a junction she sees to be free. 2A. Depresses key and repeats order to operator B. 3B. Operator B inserts plugs, using a junction she sees to be free, and 4B. Depresses key, and repeats order to operator C, 5. Who tests called subscriber's line, and, finding it free, 6. Inserts plugs. 7. Operator A receives "off," and removes plugs. 8. Operator C receives "off," and removes plugs. 9. Operator A gives "off" to operator B. 10. Operator B removes plugs.
Total 27.	Total 10.

NOTE.—Movements 1A and 2A and 3B and 4B are simultaneous, one being done with the left, the other with the right hand.

It is evident, therefore, that, roughly speaking, there is about three times the work with the American than with the Mutual system, and that the latter has but one more movement in getting a connection through three switch-rooms than the former has through one. The plan I propose is adapted to give a quicker service than the American one, even supposing the mechanically and financially impossible plan of concentrating all the subscribers' lines in one huge central switch-room were adopted. It is this fact that enables me to advocate with the fullest confidence a multiple switch-room plan as the best means of telephoning a great city. The modified Mutual system, in combination with such switch-rooms, solves the problem of how to deal with very large exchanges. It enables the greatest simplicity to be maintained throughout; it contains within itself the principle of indefinite expansion, and the larger the number of subscribers it has to cope with, the more conspicuously do its merits shine out.

The size of the switch-rooms would be kept within reasonable limits, and the apparatus consequently would be simple and cheap. The largest would be the central, but even this would have to deal with only 40,000 lines when the maximum of 160,000 subscribers came to be reached, allowing the very liberal proportion of 25 per cent. of junctions. I apprehend no difficulty whatever in arranging 40,000 lines in one room. The floor space required would only be about twice that now wanted for 5,000 lines on the American plan.

The rent and other expenses of so many switch-rooms may be urged as an objection, but I do not consider it at all a serious one. Small apartments would suffice for the sectional rooms; many of them would be in cheap neighbourhoods, and all could be top floors or attics.

It may also be said that the number of operators required would be great; but so it would be with any system, and the wages of a few score of girls are neither here nor there when the economies otherwise effected and the prize to be won by any company giving a good and cheap service in such a town as London are considered.

Such a service would, I believe, produce a circle of between 30,000 and 40,000 subscribers in the course of three or four years. But supposing that London only managed to attain the present level of Galashiels within that period, the number would be 28,000. This, at £8, would mean a gross annual revenue of £224,000, and, deducting 50 per cent. for working expenses, a net revenue of £112,000. Capitalised at 5 per cent., the sum represented would be £2,240,000, or £80 for each subscriber connected. How such an amount could be expended I cannot imagine. With a switch-room in the centre, or nearly so, of every square mile, the average length of the subscribers' lines would be only a quarter of a mile. The cost of wires, instruments and switch-room fittings would be £10 per subscriber at the outside. Debiting each subscriber with another £10 as his share of the cost of the junction lines and central, there would remain a balance of £60 per subscriber for conduits, labour, and miscellaneous expenses. I repeat that I do not know how such a sum could be spent; and I believe that, after a short experience, a subscription of £8 would be found unnecessarily high, and capable of substantial reduction. But to ensure such a result, the systematic working out of a definite plan must be insisted upon; there must be no patching of patches, and the first object of the undertakers must not be to make money by hook or by crook, but to establish an efficient exchange. That done, the rest will follow of its own accord, and the reward will be rich exceedingly.

Mr. Preece has shown us how efficient telephonic communication can be established with Paris and other distant towns; and one consequence of the adoption of such a system as I have described would be that London subscribers would be able to speak from their own offices and houses to the offices and houses of subscribers in Paris. The adoption of metallic circuits in Brussels and many other continental towns would bring them also within range. Without metallic circuits the scope of long-distance telephoning is restricted within much narrower limits; for instance, London subscribers cannot at present speak to those in Manchester or Liverpool, except by the aid of special apparatus, corresponding to that which I would make universal.

The success of the Mutual Telephone Company in Manchester may be cited as an instance of what is possible with low rates and a good service. The rate is £5 to shareholders, and £6 to others, and the average is very nearly £5 10s. The exchange commenced working on February 28th last, with 68 subscribers. On June 30th there were 413 subscribers connected, and the net profit on the month's working for Manchester centre was at the rate of 4·64 per cent. per annum; on July 31st the number connected was 506, representing a revenue of £2,840, and the profit on the month's working was at the rate of 5·04 per cent. per annum. At the same date the amount expended on the Manchester exchange was £12,469, scarcely £24 12s. per subscriber, which sum not only represented the cost of joining up the 506 subscribers, but included provision for future developments on an exceedingly liberal scale.

I think, therefore, that there is reason to believe that telephony may be both good and cheap at the same time, and that in the future it will be both.

APPENDIX.

On an existing exchange worked according to Mann's system, each operator in ordinary course of business deals with 180 connections per hour, or exactly three per minute, of which about half have to be obtained from, or given to, operators at other switch-rooms. On a special trial being made by several inspectors being put on an operator's service wire with instructions to supplement the ordinary traffic by demanding connections incessantly, the operator successfully dealt with 357 connections in exactly one hour. She therefore got through 5·95 per minute for sixty consecutive minutes, which gives an average for each connection, *including subsequent disconnections*, of 10·09 seconds. Of these she completed 92 herself, 223 had to be asked from another switch-room, and 42 were given to another switch-room. All the usual incidental work was properly performed, such as informing callers that the subscriber wanted was engaged; ringing up callers, and notifying that the subscriber previously advised as engaged could now be had; answering repeated demands from impatient callers for engaged or dilatory subscribers; informing operators at other switch-rooms that subscribers wanted could not be had, with the reasons, and subsequently advising that they were free.

Special tests were made to ascertain the rate at which connections involving the attention of three different operators (corresponding to Class 3 of the proposed London system) could be completed and subsequently got rid of. For this purpose a model conversation was arranged, each subscriber, on being rung up, being told, "This is the telephone manager's office; is there one of my inspectors at your place just now?" Two tests were made, in each case twenty consecutive connections being demanded with subscribers taken at random from the list, except that only those were selected whose connections, owing to the position of their premises, would have to be handled by three operators. It was agreed beforehand that if any subscriber called for left his bell unanswered for sixty seconds the experimenter would tell the operator to disconnect and give another. The tests took place during busy hours of the day, and were imposed on the ordinary traffic.

Test A.—Twenty connections were made, but the twelfth subscriber asked for did not answer within the regulation minute, so that only nineteen model conversations were held. The first connection was asked at 10h. 1m. 0s., and the twentieth was done with at 10h. 19m. 40s. Deducting one minute lost over the subscriber not obtained, the average for the 19 conversations had was 55·8 seconds.

Test B.—Twenty connections were asked for, but one subscriber was engaged, and two others did not answer within the regulation minute, consequently only seventeen model conversations were held. The first connection was asked at noon precisely, and the twentieth was done with at 12h. 14m. 20s. Deducting three minutes lost over the three not obtained, seventeen conversations were completed in 11m. 20s., giving an average of forty seconds per conversation. Of the 680 seconds occupied, only 136 were taken up in asking for and making the connections, the balance was consumed in ringing the subscribers called, by their delay in answering, in putting the model question, and receiving the replies, which were not always confined to a monosyllabic negative.

[CORRECTION.—In Mr. Preece's paper on "The London-Paris Telephone," published in our last issue, in the last paragraph—page 248—the figures 1·8 and 3 should read ·18 and ·3.—EDS. EEC. REV.]

OBITUARY.

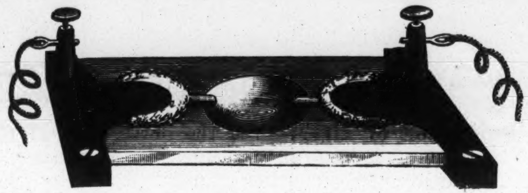
MR. LOUIS JOHN CROSSLEY.

IT is with very great regret that we record the death of Mr. Louis John Crossley, J.P., which occurred last Sunday morning at Moorside, Halifax. The deceased gentleman had been ailing for the past five years, suffering from an affection of the brain. He endeavoured by a long sea voyage to recover his health, and though he was somewhat improved on his return, there was a gradual decline in vigour. Mr. Crossley was the only son of the late Mr. John Crossley, of Manor House, and was born on May 31st, 1842, in Wade Street, Halifax. He attended University College School, London, when a boy, but on account of delicate health he was withdrawn from the school and placed under a private tutor at home. At the beginning of 1859 he went to business at the Dean Clough mills, where he laboured in the wool department as an ordinary artizan. He developed a talent for mechanics, and became an authority on boilers and machinery generally. He is the author of several inventions, one of his earliest being the Crossley anemometer, a gauge for recording the velocity and pressure of the wind. In conjunction with M. Breguet, Mr. Crossley took out a patent for an alphabetical telegraph instrument. When Professor Graham Bell's invention of the telephone was announced, Mr. Crossley secured the first telephone that came to this country, and had it fixed to the wires at Dean Clough, in place of the Crossley-Breguet instruments then in use. Finding that the telephone lacked the efficiency which was necessary to make it useful for commercial purposes, Mr. Crossley set hmself to improve it, and ultimately took out a patent for the Crossley transmitter, by means of which a message was rendered more audible. It proved a most remunerative invention, for the United Telephone Company, Limited, made overtures to Mr. Crossley, and ultimately gave him £20,000 for the patent. A great hobby of Mr. Crossley's was the building and fitting up of one of the best private laboratories in the kingdom. A description of this appeared in the REVIEW of February 3rd, 1883. In the town of Halifax Mr. Crossley was well known and appreciated, and his death removes a well-known figure in Yorkshire.

ELECTRO-MICROSCOPIC SLIDE FOR TESTING THE ANTISEPTIC POWER OF ELECTRICITY.

The figure shown below, from the *Scientific American*, represents an instrument devised by Robert L. Watkins, M.D., of New York, for the purpose of ascertaining whether electricity would destroy the life of germs or not.

It is the result of a number of experiments to confirm the belief the inventor has long held, that electricity is an antiseptic and disinfectant, and it was while engaged in these experiments that he discovered that Apostoli had made the same claim.



The instrument consists of a glass slide, in the centre of which is a sunk cell. Two grooves, each $\frac{3}{4}$ of an inch long, run from the sunk cell outward. Two brass pieces are fitted over the extremities of the slide in such a way that the rounded points, the under surfaces of which are lined with platinum, will extend over the outer ends of the grooves. These rounded points do not touch the glass, but are raised above the grooves about $\frac{1}{8}$th of an inch.

Binding posts are attached to the brass pieces for connection with a battery. To apply the instrument a sufficient quantity of the fluid containing the bacteria should be used to fill the sunk cell and grooves. A cover glass is placed over the cell and its contents. Two small clean sponges saturated with either the fluid or distilled water are then placed underneath the platinum points and in contact with the fluid in the grooves. The bacteria are now ready for observation, the electricity is turned on, and the quantity noted by the milliampère meter until all signs of germ life disappear. They can afterwards be cultivated on gelatine in the usual way, if desired, to determine whether their vitality has been entirely destroyed. Other uses for this slide will readily occur to one working in the same field. For example, the effect of electricity on the blood and different tissues. This instrument was found very satisfactory, not only as an easy but as a quick way of finding out the amount of electricity required to destroy these micro-organisms.

NOTES.

Chicago Electric Lighting.—It is stated that some sixteen-story buildings, recently erected at Chicago, present a very imposing appearance. The buildings are to be lighted throughout by electricity, and they will be wired for 4,500 lights.

Destruction of Electric Light Plant by Fire in America.—The Richmond Electric Light, Heat, and Power Company's station at St. George, Staten Island, N.Y., was totally destroyed by fire on August 3rd. The loss is estimated at about $50,000, but this is fully covered by insurance.

Transformer System in Germany.—The second town in Germany lighted on the alternating current transformer system is, says a contemporary, Landsberg on the Lech. Overhead conductors are in use, and 700 lamps are lighted at present.

New Electrical Journal.—A new monthly journal, entitled *The Transmitter*, published in the interests of the Electric Telegraph Society of New South Wales, has recently been commenced. The first two numbers, of which we have been favoured with copies, are very creditable productions, and augur well for the future.

New Pattern Locomotives.—A Chicago firm is building two new engines which promise a revolution in locomotive building. The engines consume their own smoke and have no smokestack. They are fitted up with an electric head-light, which is placed on a stand immediately in front of the boiler, thus giving the engineer an unobstructed view of the line ahead. The new engines will furnish power for lighting passenger trains with electricity.

Electric Power for Moving Bridges.—The operation of swing-bridges seems to be the latest American application of electric power. The Rush Street Bridge, Chicago, which is a massive structure weighing about 800 tons, is moved in this way. Situated close to the mouth of the Chicago river, this bridge has to undergo a very heavy road traffic, and during the navigation season the river traffic is almost constant, and for the larger craft the bridge has to be turned. The bridge is 240 feet long and 59 feet wide, resting on a turntable 48 feet in diameter.

Electrical Welding.—A few weeks ago, Mr. G. D. Burton gave an exhibition at Boston of electrical welding or forging. One experiment was the melting into liquid form of a bar of steel an inch in diameter and 12 inches long in 45 seconds without raising the temperature of the room a single degree. Another exhibit was the forming of an auger screw, the flat bar of iron being fastened in the machine at the two ends, and heated almost instantly, and then twisted into the required spiral by the automatic turn of the machine. These experiments were witnessed by Dr. W. H. Wahl and others.

Liége University Electro-Technical Section.—One of the first schools for teaching the science and applications of electricity to industry was opened at the University of Liége, the town to which Gramme came to work, and at the same time to study geometry and mathematics at the free classes for adults. Had it not been for the knowledge he thus acquired at Liége, he would never have been able to understand the theories of the Italian *savant* Pacinotti, and to apply them in an invention which has made his name celebrated in every civilised country. One of the first schools of electricity was opened in 1883, at the same University. The initiative of this creation was taken by M. Montefiore-Levi, the Belgian senator and philanthropist. In endowing the University of Liége with an electro-technical section, M. Montefiore-Levi commenced by placing a sum of one hundred thousand francs at the disposal of the Government for the preliminary cost of the purchase of the necessary instruments and materials, but since then he has gone on giving annually larger amounts, in proportion as the needs of the new school grew with its rapid development. The Government, on its side, furnished the buildings, but as the University of Liége was being rebuilt, the electrical section was at first housed in modern constructions in the court-yard of the main buildings. This year it has been allotted a thoroughly appropriate building, containing workshops and laboratories. It is, indeed, so spacious that it has been possible to provide a separate laboratory for every two students of electricity. On this occasion M. Montefiore-Levi has given one hundred and fifty thousand francs to provide the workshops and laboratories with all the necessary instruments and materials to enable students to make, not only the experiments requisite for their studies, but also experiments for new discoveries and inventions. The practical utility of the institution has been already amply demonstrated. All the students who have in any way distinguished themselves are sought after by the chiefs of the electrical industry. The Italian Government has followed the example set at Liége by creating a similar electrical school at the University of Milan. But though the electrical section of the Liége University owes its existence to M. Montefiore-Levi, its success and rapid development have been due to the untiring exertions of Prof. Eric Gérard, who has presided over it ever since it was created. He is a comparatively young man, having been born at Liége in 1856. When twenty-two years of age, he left the University of Liége and completed his electrical studies at the Belgian *Ecole Supérieure de Télégraphie*. M. Gérard has also written largely on electrical science.

Double and Triple Currents.—Considerable discussion has arisen upon this subject, as to who really first thought of using double and triple current work. The credit is due to either Mr. Tesla or Professor Ferraris. The former should surely have all the credit of the invention, seeing he patented a practical and commercial motor on that principle. *Industries* thinks Tesla has done far more to make it a thorough success than anyone, and it is hoped he will get something more substantial than mere abstract credit. Modifications such as using closed coil armatures or triple currents with three wires, though they may be improvements, can never in comparison, rank as original inventions.

Hosking's Electric Ballot Vote Counter, Scrutineer and Detector.—The electric ballot vote counter, scrutineer and detector, the invention of Mr. Albert W. Hosking, of West Smithfield, E.C., is designed to secure the greatest possible degree of precision and accuracy in the counting of the votes given at elections by ballot, to guarantee inviolable secrecy in the counting operation, and to provide the means of securing these desirable ends at less cost than that associated with the tedious and uncertain system now employed. Briefly stated, the component parts of the invention, consist of :—1. The introduction of a circular voting stamp or label, with conducting surface, to be placed by the voter within a circular voting space on the ballot paper, in substitution for the pencilled cross now employed; 2. A travelling arrangement of electrodes designed to make contact with the voting stamps when the voting papers are subjected to its operation for the double purpose of enumeration and scrutiny; and 3. An electric indicator screen on which the names of the candidates are prominently displayed over dial plates attached to clockwork counters, by which record is made of all electric impulses received through the voting stamps during the process of counting. The counting apparatus consists of a long table having a central bed of the width of the voting papers, across which they are laid lengthwise in four sets of ten each, the voting spaces forming continuous parallel columns from end to end of the table. On either side of the central bed, and extending its whole length, are piano wire conductors, in number corresponding to the number of candidates, one conductor on each side for each candidate. In contact with these wires, and bridging the central bed of the table, is the carriage of electrodes, having what may be termed external "wings" constructed to give separate electrical connection to each of the conductors. In the front of the carriage are pairs of insulated rollers, constituting "positive" and "negative" couples, corresponding in number to the number of the candidates, one pair to each. These metallic rollers are so arranged that when the carriage is moved along, which is done with considerable speed, one pair passes over each column of voting spaces. Immediately they touch a voting stamp, an electric circuit in which a vote-counting indicator is placed is completed, and the vote is instantly recorded. Ten such contacts and records can be made in the space of one and a-half seconds. The votes are recorded on the "indicator screen," which bears on its face the name of the several candidates placed above the dials, which accurately reflect each closing of the electric circuit resulting from the rollers appropriated to a particular candidate coming into contact with a voting stamp placed for him on the voting paper. The clockwork counters are set in motion by the release of an escapement bar, and the consequent dropping of a weight which actuates them. The machine which the patentee has constructed for the purposes of these demonstrations is for an actual five-candidate County Council contest, and the five weights, each bearing the name of the candidate whose counting mechanism it actuates, are exposed to view, their comparative rate of descent indicating the progress made by the respective contestants from one moment to another. The weights could, of course, be concealed if desired. But the indicator screen is also made to serve another purpose—that of announcing, by the ringing of an alarm bell affixed to it, every occasion upon which the carriage of conductors on the table passes over a voting paper which has affixed to it a number of voting stamps in excess of the number of votes allowed. The alarm bell continues ringing until stopped by the operator, and the irregular paper, which is thus discovered and indicated, is then marked as "disallowed."

The Electric Lighting of Trains in France.—It is reported that after several successful experiments with the electric lighting of the trains on the Paris, Lyons, and Mediterranean line, the company have definitely decided to light the whole of their trains in that way.

Price of Electricity in Madrid.—The German Electric Supply Company in Madrid, have reduced their charges from the basis of 1s. 3d. per unit to 11½d., which makes the cost of electricity in Madrid less than that of gas. The English Company still charge 1s. 3d. per unit for private lighting.

Electric Light at Arbroath.—The electric light has been introduced into Mr. Lowson's Baltic works, Arbroath, one of the largest spinning mills and power-loom factories in the town. This is the first introduction of the electric light into Arbroath.

Production of Zinc.—Since the development of the electro-technical industry in Germany, greater stimulus has been imparted to the production of zinc in the country. Out of a total annual output throughout the world of, in round figures, 350,000 tons, Germany alone produces about 140,000 tons, or 40 per cent. of the whole. The outturn increased from 105,500 tons in 1881 to 139,270 tons in 1890.

Transmission of Power at Frankfort.—Prof. Ayrton writes to us from the Electrical Exhibition, Frankfort-on-the-Main, on Friday, August 28th as follows :—"As there have been rumours that the transmission of power from Lauffen to Frankfort was not going to succeed, you may be interested to hear that I saw to-day some 900 sixteen candle glow lamps in the Exhibition at Frankfort supplied with current produced by water power at Lauffen, 175 kilometres away, some 12,000 volts being used in the transmission. So some 50 or 60 horse-power has been transmitted."

Electric Light Accident on a Train.—We cull the following from our contemporary, the *Daily Telegraph*, of August 28th; but we have not, so far, learnt whether the fire originated with electrical current or if it arose from mechanical friction. Apparently the latter was the cause :—"Yesterday morning an accident happened to a Great Northern train running from Barnet to Moorgate Street. The carriages are lighted by electricity, the current being supplied by a dynamo placed in a special compartment attached to the rear guard's van. It is stated that soon after the 9.15 train left Finchley Station the rear guard discovered that flames were issuing from the electrical chamber, and that fire had taken considerable hold of the woodwork. By opening the air valve he released the vacuum brake and brought the train to a standstill. A gang of porters from Finchley Station was quickly on the spot, and by the plentiful use of water got the fire under. A telegram was despatched to Finsbury Park, where an electrician met the train. It was then found that the dynamo was intact, and that the light was available for the remainder of the journey."

Industrial Electrolysis.—Electricians have an idea—generally a somewhat vague idea—says *Industries*, that there are untold millions to be won by inventors of processes for obtaining soda, bleaching powder, zinc, copper, and various other articles, by means of electrolysis. A little study of any particular article, such as soda, shows that energetic people have been working at the subject for half a century. Ninety per cent. of the workers have probably been ignorant of chemistry or of electricity, or of both; but the remaining tenth probably understood the matters they were working at. It would be a great benefit to the inventive community if some one who has a competent knowledge both of electricity and chemistry were to study the question of commercial electrolysis and write a book or a paper on it. Such a work should not contain mere catalogues of proposed processes, but should say whether they worked or not, and, if they failed, should state why. It would be well worth the while of one of our technical societies—say, the Institution of Civil or of Electrical Engineers— to get such a paper and inaugurate a discussion on the subject.

Pendant Switches.—Messrs. Hills & Thomson, of Liverpool, inform us that they will be glad to hear if there is such a thing to be had as a reliable pendant switch composed solely of earthenware or other incombustible and non-hygroscopic material with the necessary metal parts. They require two forms, one for attachment to or in combination with a bayonet-socket lampholder, and the other to hang on the end of a flexible cord separate from the lamp.

Personal.—Mr. J. Edward Waller, who has for many years been associated with Mr. Joseph Kincaid, as his manager, has entered into partnership with Mr. Edward Manville, consulting electrical engineer. They will carry on, at 39, Victoria Street, Westminster, S.W., the profession of consulting civil and electrical engineers, a highly desirable combination in the rapidly advancing condition of the applications of electricity.

Weymersch Battery.—On Friday and Tuesday last, special demonstrations of this battery were given at the offices of the Weymersch Battery Syndicate, in Victoria Street. Recently some mechanical improvements have been introduced, which render the manipulation of the battery extremely simple. One important feature is that the zincs can be renewed without loosening a terminal, contact being made by means of mercury, into which the tops of the zincs dip. We understand that in cases where the battery has been in use for some time, furnishing current for 15 to 20 lights, it has given every satisfaction. We are informed the cost works out at something like 1s. 6d. per unit.

The Thomson European Electric Welding Company.—The Thomson European Electric Welding Company, the founders' shares of which were being subscribed for in London at a high premium a short time ago, has granted the purchasers of the patents for Great Britain until September 1st to pay the balance of £30,000 due upon the contract. The company has already received $320,000. The option of the German parties has also been extended to September 1st. For a royalty on the welds made, the company has given a licence for the use of the projectile patents all over Europe, and it is thought by some that this will prove the most profitable branch of the electric welding business in Europe.

Telegraphic Communication with Lundy Island.—At a recent meeting of the Cardiff Chamber of Commerce, it was stated that a letter had been received from the committee of Lloyd's inquiring whether the Cardiff Chamber or the Associated Chambers would guarantee Lloyd's any fixed number of messages if the latter arranged for telegraphic communication between Lundy Island and the main land. The cost of the establishment of this communication and its maintenance would be about £600 per annum. The secretary had replied to the effect that the matter was one purely for the Government, and no further action was taken. Our readers will probably remember that eight or nine years ago Lundy Island was telegraphically connected with the main land by the efforts of a small private company, which, after many vicissitudes, abandoned the scheme some twelve months ago and put up the cable and accessories for sale.

Wynyard Park Lighting.—The installation at the above, which has been designed and erected by Messrs. Drake and Gorham for the Marquis of Londonderry, is now complete, and has been found to work most satisfactorily. It consists of upwards of 1,000 lamps, supplied by two horizontal compound Davey-Paxman engines, and one vertical Robey engine. The dynamos are two 40-unit Kapp machines and one 15 unit, manufactured by Messrs. Johnson and Phillips, for whom Messrs. Drake and Gorham are acting as London agents. There are two boilers, which provide steam for the pumping and driving of a Merryweather steam pump for fire extinction. The existing handsome fittings throughout the building have been adapted, and as far as possible the aim of the contractors has been to produce the same effect as before the introduction of the electric light. The carrying out of the work has been superintended by Mr. A. A. Campbell Swinton.

Ferranti, Limited.—This company has just issued a catalogue giving particulars of the Ferranti alternating current dynamos, transformers, switchboards, high-tension fuses and concentric mains (Ferranti safety system).

The Morocco Cable.—The laying of the Spanish cable to Morocco called forth, says a Madrid telegram, a strong resistance from the Moors of the Anghera tribe, 150 of whom attacked the telegraphists at Tangiers, during the final operations of laying the wire, and put them to flight. The Spanish Minister addressed a remonstrance to the Sultan on the subject, and it is believed that the work will be resumed, but meanwhile the cable has been laid since Tuesday last. Much blame is attached to the Spanish representative in Morocco for his apathetic attitude in the matter.

Convention of the Association of Edison Illuminating Companies in New York.—The seventh convention held by the association was opened on August 11th, and there was a good attendance of members. The morning of the second day was occupied in the discussion of Mr. A. E. Kennelly's report on the "Grounding of the Neutral Wire in Three-Wire Systems," which was read the previous day. This discussion was followed by a paper by Prof. Wm. D. Marks, of the Edison Electric Light Company of Philadelphia, the title of his paper being: "How to get Paying Loads for Stations." Next came a paper by R. S. White, on "The Edison Meter in the Brooklyn Station." The morning session was concluded with an address by Mr. S. Insull, second vice-president of the Edison General Electric Company, on the present business policy of the parent company, the outlook in the patent suits, the condition of the business, &c. In the afternoon session of the second day the following papers were read:—Leigh Carroll, Birmingham, Ala., on "Some Practical Ideas on Distribution;" A. E. Kennelly, on the "Mechanical Meter;" W. S. Howell, on "Peculiar Features of Edison Feeder Systems;" and W. J. Jenks, on the "Success of the Mutual Insurance Idea in Electric Lighting and Power Stations." After the re-election of officers, the last paper was read by L. Stieringer, his subject being "Incandescent Lamps for Decorative Purposes."

The Electric Light at Portsmouth.—At one time it was thought that the introduction of electric lighting into Portsmouth would be left to private enterprise. A company was formed, but the Town Council afterwards determined to apply for an order, and the company was dissolved. Mr. James N. Shoolbred, C.E., was consulted as to the best method of complying with the obligations imposed by the electric lighting order for the supply of electricity for private purposes, and as to the most suitable method of providing electricity for lighting certain public thoroughfares. Mr. Shoolbred came to the conclusion that the low-pressure system would suffice. Mr. Shoolbred suggests the use of continuous currents at low pressure, supplemented by the use of storage batteries, and distributed on what is known as the three-wire system. The capacity of the electrical installation which he recommends to be laid down at first would be of a maximum output of 5,000 lights, each of 16 C.P., burning at one and the same time. The buildings at the generating station should, however, be constructed large enough to contain without addition generating plant for about double the electrical output above mentioned, so as to allow for reasonable extensions to the first supply, such as may be expected to follow within a moderate time after the commencement. For driving the electric lighting machinery, Mr. Shoolbred recommends steam engines capable of developing 150 and 75 I.H.P. respectively. The total expense for private lighting, according to electric lighting order, is estimated at £46,310. The estimate for public lighting by arc lights was £11,550. The electric lighting committee, in submitting Mr. Shoolbred's report, expressed the opinion that the scheme contained therein was the best that could be adopted. The committee further report:—"The committee consider that a sum of £60,000 will be required to carry out the scheme dealt with in Mr. Shoolbred's report, which they recommend be adopted, and that application be made to the Local Government Board for their sanction to the borrowing of £60,000."

Berend and Company.—Messrs. O. Berend & Co., of 61, Fore Street, have now moved into their new show-rooms in the same building.

General Electric Company. — We have received special circulars from the General Electric Company descriptive of their micro-telephones and of the "Lancashire" pendulum movement indicators.

Salford Sanatorium Lighting.—At Tuesday's meeting of the Salford Council a resolution of the General Health Committee accepting the tender of the Manchester Edison-Swan Electric Lighting Company for the electric light installation required at the sanatorium, in accordance with specifications prepared by the council, for the sum of £1,312, was adopted. Mr. Alderman W. Robinson said that they would save £300 by adopting the system now proposed.

The Edison Dynamo.—"Messrs. Austin & Myers having expressed a desire to furnish proof of the remarkable results obtained with their "Infant" dynamo as compared with that "badly proportioned, poorly designed, inefficient machine" to which they make comparison, it will be interesting to know the voltage, so that the output may be calculated in watts. This trifling omission on their part might possibly affect the result."—S. W. CUTTRISS.

A Good Idea.—There are persons to be found in the Patent Office Library and the British Museum Reading-room who are seeking employment, and others who, having work to be done, do not know to whom to apply. These two classes of would-be employees and employers might very likely be glad to meet, and with this object in view, the *Bibliotheque Nationale*, of Paris, is now setting a good example which, we imagine, would lead to satisfactory results in London. There is a register where every person writes down the work, research, or translation he is willing to have done or do, as the case may be, and it seldom happens that an enquiry remains unanswered for 24 hours. It appears that this system answers far better than an advertisement in the papers.

Manchester Electric Lighting.—At the last meeting of the Manchester Town Council, Mr. Brooks moved the approval of the proceedings of the Gas Committee, together with a resolution to apply to the Local Government Board to sanction the borrowing of £150,000 for the purpose of carrying out the electric lighting scheme of the Corporation. Sir John Harwood, in seconding the resolution, said that they consulted a considerable number of the best known electrical engineers, and that morning he had a final conference with Dr. Hopkinson. The whole of the arrangements had been placed in his hands. The scheme would involve oversight for twelve months after it was finished. The resolution was adopted.

Prof. Lodge's New Book.—It may be remembered that in the spring of 1888 Prof. Oliver Lodge, F.R.S., gave two lectures on Lightning Conductors to the Society of Arts, in which he promulgated several revolutionary views on the subject, and supported them by a series of direct experiments with Leyden jars. The experiments also branched off into a study of electric waves, a subject which was being simultaneously worked at in Germany by Hertz. At the British Association meeting in Bath the same year, Prof. Lodge's views were goodnaturedly controverted by Mr. W. H. Preece, partly for the purpose of raising a discussion, and partly because some of them were rather startling. Since then a more complete communication from Prof. Lodge to the Institution of Electrical Engineers, as well as a recent paper read before the Royal Society, are generally held to have fairly substantiated the new views, and we understand that during the present year Prof. Lodge has been engaged in welding together the principal portions of all this literature, with sundry additions, and that Messrs. Whittaker & Co. propose to issue it as a large volume of their specialists' series in the course of the autumn.

Rumoured Cable Rupture.—It is stated that Balmaceda's officials at Coquimbo have cut the English cable.

French Telegraphs.—*La Lumière Electrique* states that the French telegraph receipts for the month of July show a diminution of 274,000 francs on the corresponding period of last year.

Delta Metal.—The Delta Metal Company have taken premises for their foundry and engineering works at 29, Pomeroy Street, New Cross Road. The head office remains at 110, Cannon Street.

Electric Lighting of a Lunatic Asylum.—The Vermont (U.S.A.) Insane Asylum has recently been installed with the electric light. The plant, which has been erected by the Giant Electric Motor Company, of Portland, M.E., U.S.A., consists of two arc lamps and 300 incandescent lamps, current for which is provided by two Atlas engines and a dynamo.

Shrewsbury Town Council and Electric Lighting.—The Town Council have granted an application which has been before them from the Shropshire Electric Light and Power Company Limited, that they should consent to the company's application to the Board of Trade for a license to erect and maintain electric lines and works, and to supply electricity in the borough.

Electric Lighting of Cambray.—The work of lighting the French town, Cambray, by electricity has now been carried out. The inhabitants of the town are tolerably wealthy, and this fact is inducing them to have the electric light installed in every room in the houses—from the cellars to the garrets. A noteworthy feature is the fact that the whole of the capital necessary for carrying out the work has been provided by the population with great enthusiasm.

Electric Railway at Sissach, Switzerland.—An electric railway about two miles in length has recently been opened at Sissach, in Switzerland. Power is obtained from a waterfall by means of a turbine which drives a 35 kilowatt dynamo giving 50 ampères at 700 volts. The rolling stock of the line consists of one motor car, four passenger cars, and four cars for carrying merchandise, &c. The whole of the work has been carried out by the Oerlikon Maschinenfabrik.

Convention of Telegraphists in America.—The recent conventions of the Old Time Telegrapher's Association and the Society of United States Military Telegrapher's Corps, held at Washington recently, was the most interesting meeting of these organisations. Much interest was shown in the question of securing recognition of the members of the military corps by Congress. The address of the President, W. R. Plum, treated almost exclusively with this topic, and is very interesting.

Picture Reflectors.—Messrs. Frank Suter & Co. are wiring and lighting the picture galleries of Messrs. Dowdeswell and Dowdeswell, New Bond Street, and also those of Messrs. McLean & Co., Haymarket, using their registered picture reflectors. The same firm is employed to fit up the new works and offices of George Newnes, Limited, with 300 lights, and to supply a complete lighting plant for 400 lights for Messrs. R. D. and J. B. Fraser, Museum Street Buildings, Ipswich.

Secret Telephones.—A French proverb says, "Les murs ont des oreilles," *i.e.*, "You can be heard through the walls," and it is now becoming the fashion in France to have a telltale in the shape of a miniature microphone, enabling persons in a building to listen to any conversation which may be going on in any other room. These "secret telephones," which should be patronised only by the police authorities, are very small and nicely made. They can be placed out of view in any part of a room, or can be made to form part of a picture or painting, and remain out of sight.

An Electrician Drowned.—Mr. George Muller, aged twenty-one, an electrical engineer, son of Mr. Carl Muller, a sculptor, of Camden Square, was drowned last week while bathing in Hampstead-Heath bathing-pond. The deceased was a well-known member of the Old Students' Association.

Guernsey Electric Railway.—As the Channel Islands are outside the provisions of the Board of Trade, the supervision of the erection of the line is being carried out by the Special States Committee, who have appointed Mr. Bernard Drake as their electrical adviser.

Bank Lighting in Spain.—The last number of the *Architect* contains several illustrations of the magnificent new buildings of the National Bank of Spain in Madrid. The building, the main front of which extends nearly 550 feet, is lighted throughout by electricity, the necessary current for which is taken from the mains of the German Supply Company in Madrid.

The First Electric Railway in Russia.—The first Russian electric railway with overhead conductors, is now being constructed at Kiew by the Allgemeine Elektricitäts Gesellschaft of Berlin. This is considered an important concession, and it is expected to lead to a number of similar contracts in the Russian Empire, where electrical enterprise has hitherto been kept in the background.

The Crystal Palace Electrical Exhibition.—The Crystal Palace Electrical Exhibition will be an International Exhibition, under the provisions of the Patents, Designs, and Trades Marks Act, 1883. The exhibits of Her Majesty's Government will include historical telegraphic and electrical apparatus, instruments, and appliances, as well as the modern apparatus and instruments now in use in the Postal Telegraph Department. This exhibit will be arranged under the direction of Mr. W. H. Preece, F.R.S.

An Enterprising Electric Light Superintendent.—It is often said that electrical men are never without resources. This statement, however, is especially applicable to the manager of the Pittsfield Electric Light Company, Mass., who was informed, on very short notice, that the water was to be cut off for repairs to the main. Electric light plant cannot, of course, be run without water, and the question was how to get sufficient quantities of it. The manager at once had four large street sprinklers filled with water, and placed near the boiler. A lot of extra men were then started out, and returned with 183 water-tight barrels, which they filled with water. When the city service was turned off, the pump was connected with the street sprinkler, and the waggon was kept full by passing the water from the barrels. It was a hard job, but it worked successfully, and the lights did not waver once during the night, although the water was shut off at six o'clock.

CITY NOTES.

The Aluminium Company, Limited.

The following report was submitted to the fourth ordinary general meeting, held at the Cannon Street Hotel on Wednesday last:—

The market price of aluminium has further declined to about one-third of what it was at the date of the last report. At the present figure it is more beneficial to sell sodium direct than to employ it in the manufacture of aluminium.

The directors have accordingly been turning their attention to the development and extension of the sodium branch of the company's business, and their efforts in this line have met with a considerable measure of success. By experiments conducted at Oldbury, new methods have been worked out for the preparation, by means of sodium, of various important chemical products. The directors hope that the increased use of sodium already resulting from these experiments will enable the company to avoid liquidation.

The trading account shows a loss of £6,174 14s. 5d. But this does not quite fairly represent the transactions of the year, the deficiency being mainly due to writing down the value of stock, and to loss incurred during the first three months of the financial year. During the last nine months the Oldbury works have been more than paying their way.

The directors may remind the shareholders that the difficulties in which the company finds itself are due to the phenomenal fall in the value of aluminium, which, in consequence of the introduction of electrical processes of manufacture, now sells for little more than one-thirtieth of its price at the time the company was formed. They desire further to repeat the statement made in the last report, that eventually a large writing down of capital will be necessary, but the directors deem it useless to incur the expense involved in this proceeding in the absence of any immediate prospect of a dividend.

The retiring directors are John S. Parkin, Esq., and Sir Henry E. Roscoe, M.P., both of whom, being eligible, offer themselves for re-election.

The auditors, Messrs. Broads, Paterson & Co., retire, and offer themselves for re-election.

The Secretary having read the notice convening the meeting,

The Chairman (Mr. G. W. Balfour, M.P.) said that the directors regretted being unable to give a more favourable account of the company's prospects. The general character of the difficulties they had had to encounter was fully explained at the last meeting. When the company was formed, the price of aluminium was from 60s. to 70s. per lb. Up to that time no improvements had been made in the processes of manufacture of the article for a good many years. The first important improvements were those which this company was formed to work, and by means of them it was calculated that the selling price might be reduced from 60s. to about 20s. per lb., leaving, at the same time, a margin of profit to the company for the monopoly of the trade in aluminium. The introduction not long afterwards of electrical processes for the preparation of the metal completely upset those calculations, and the prices rapidly fell. At the last meeting it stood at from 6s. to 8s. per lb. It seemed improbable that the price could have fallen lower, but at the present moment it had actually fallen to 2s. per lb. The only hope remaining for the company was in the sodium branch of the business, of which they had the monopoly; but the difficulty was to obtain a market for all the sodium they could produce. After considerable observations regarding the affairs of the company, the Chairman moved that the report and accounts be adopted.

A Shareholder (Mr. J. F. Cheetham), then addressed the meeting in very forcible terms, and closed by moving a resolution: "That the motion be not adopted, but the meeting proceed forthwith to appoint a committee of shareholders to fully investigate the condition of the company's affairs, and report to a future meeting." This was seconded, but after considerable discussion, the resolution was lost by a large majority.

The Chairman then formally proposed, Sir Andrew Clark seconded, and it was carried: "That the directors' report and accounts be received and adopted, and entered upon the minutes."

Mr. John S. Parkin and Sir Henry Roscoe, M.P., F.R.S., were then re-elected directors of the company, and the auditors, Messrs. Broads, Paterson & Co., were also re-elected.

A vote of thanks to the chairman and directors closed the proceedings.

The Western and Brazilian Telegraph Company, Limited.—It is officially announced that, under the arrangements recently concluded with the Brazilian Government, the system of the Western and Brazilian Telegraph Company, Limited, has been strengthened by loop cables being laid from Pernambuco to Bahia, Bahia to Rio de Janeiro, and Rio de Janeiro to Santos, thus giving a complete duplicate service of cables from London to Pernambuco. Bahia, Rio de Janeiro and Santos, in Brazil, and thence a direct cable for the service with the River Plate. These new cables will afford greatly increased facilities in the working of the traffic between South America and Europe, &c.

The Direct Spanish Telegraph Company, Limited.—The Board have decided to-day to recommend the payment of the dividend at the rate of 10 per cent. on the Preference shares, and a dividend at the rate of 5 per cent. (free of Income Tax) upon the Ordinary shares for half year ended 30th June last.

W. T. Henley's Telegraph Works Company, Limited.—The ordinary meeting of this company was held at Cannon Street on Tuesday last, but our representative was refused admission.

TRAFFIC RECEIPTS.

The Brazilian Submarine Telegraph Company, Limited. The receipts for the past week amounted to £4,739.

The City and South London Railway Company. Traffic receipts for the past week amounted to £717.

The Cuba Submarine Telegraph Company, Limited. The estimated traffic receipts of the Cuba Submarine Telegraph Company, Limited, for the month of August, were £3,000, as compared with £2,913 in the corresponing month of last year.

Direct Spanish Telegraph Company, Limited. The estimated traffic receipts for the month of August, 1891, are £1,631, as against £2,075 in the corresponding period of last year.

The Eastern Extension, Australasia, and China Telegraph Company, Limited. —The traffic receipts for the month of August amounted to £41,791, as against £46,526 in the corresponding period, showing a decrease of £4,735.

The Eastern Telegraph Company, Limited. The traffic receipts for the month of August were £53,398, as against £52,606 for the same period of 1890, an increase of £797.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending August 28th, 1891, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Company were £3,215.

The West India and Panama Telegraph Company. The receipts of the West India and Panama Telegraph Company for the month of August show a decrease of £951 as compared with the corresponding period.

SHARE LIST OF ELECTRICAL COMPANIES.

Present Amount Issued.	Name.	Stock or Share.	Closing Quotation. (August 27th.)	Closing Quotation. (Sept. 3rd, 1891.)	Business done during week ending (Sept. 3rd, 1891.)	
					Highest.	Lowest.
250,000*l*	African Direct Telegraph, Ltd., 4 p. c., Deb. Regd. and to Bearer	100	99 —102	99 —102	...	...
1,300,980*l*	Anglo-American Telegraph, Limited	Stock	47 — 48	47 — 48	49	$47\frac{7}{8}$
2,849,510*l*	Do. do. 6 p. c. Preferred	Stock	86 — 87	86 — 87	$87\frac{3}{4}$	86
2,849,510*l*	Do. do. Deferred	Stock	$11\frac{3}{4}$— $12\frac{1}{4}$	$12\frac{3}{4}$— $13\frac{1}{4}$	14	$11\frac{7}{8}$
130,000	Brazilian Submarine Telegraph, Limited	10	$11\frac{3}{4}$— $12\frac{1}{4}$	$11\frac{3}{4}$— $12\frac{1}{4}$	...	...
53,200*l*	Do. do. 5 p. c. Bonds	100	99 —102	99 —102	...	...
75,000*l*	Do. do. 5 p. c., 2nd Series, repayable in June, 1906 ...	100	103 —107	103 —107	...	...
77,978*l*	Brush Electrical Engineering Ordinary, Nos. 1 to 63,416	3	$2\frac{3}{8}$— $2\frac{5}{8}$	$2\frac{1}{2}$— $2\frac{3}{4}$	$2\frac{5}{8}$	$2\frac{1}{2}$
69,996*l*	Do. do. Non cum. 6 p. c. Preference, Nos. 1 to 63,416	2	$1\frac{3}{4}$— 2	$1\frac{7}{8}$— $2\frac{1}{8}$	$1\frac{15}{16}$	...
50,000	City and South London Railway, Nos. 1 to 50,000	10	3 — 5	3 — 5	...	...
$7,716,000	Commercial Cable, Capital Stock	$100	107 —109	107 —109	$108\frac{3}{4}$	...
224,850	Consolidated Telephone Construction and Maintenance, Limited ...	14/-	$\frac{3}{8}$— $\frac{1}{2}$	$\frac{3}{8}$— $\frac{1}{2}$	$\frac{1}{2}$	...
20,000	Crompton & Co., Ltd, 7 p. c. Preference Shares, Nos. 1 to 20,000	Stock	4 — 5	$4\frac{1}{2}$— $5\frac{1}{2}$	...	...
16,000	Cuba Telegraph, Limited	10	10 — 11	10 — 11	$10\frac{11}{16}$	$10\frac{5}{8}$
6,000	Do. do. 10 p. c. Preference	10	$16\frac{1}{2}$— $17\frac{1}{2}$	$16\frac{1}{2}$— $17\frac{1}{2}$	$16\frac{1}{16}$	...
12,931	Direct Spanish Telegraph, Limited, ... (£4 only paid)	5	$3\frac{3}{4}$— $4\frac{1}{4}$	$3\frac{3}{4}$— $4\frac{1}{4}$	...	...
6,000	Do. do. 10 p. c. Preference	5	$9\frac{1}{2}$— $10\frac{1}{2}$	$9\frac{1}{2}$— $10\frac{1}{2}$	...	...
60,710	Direct United States Cable, Limited, 1877	20	$10\frac{3}{4}$— 11	11 — $11\frac{1}{4}$	$11\frac{3}{4}$	$10\frac{15}{16}$
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	$14\frac{1}{4}$— $14\frac{1}{2}$	$14\frac{3}{8}$— $14\frac{5}{8}$	$14\frac{9}{16}$	$14\frac{3}{8}$
70,000	Do. 6 p. c. Preference	10	15 — $15\frac{1}{2}$	15 — $15\frac{1}{2}$	...	...
200,000*l*	Do. 5 p. c. Debs. (1879 issue), repay. August, 1899	100	107 —110	107 —110	...	...
1,200,000*l*	Do. 4 p. c. Mortgage Debenture Stock	Stock	107 —110	107 —110	...	...
250,000	Eastern Extension, Australasia and China Telegraph, Limited ...	10	$14\frac{7}{8}$— $15\frac{1}{8}$	15 — $15\frac{1}{4}$	$15\frac{3}{16}$	15
78,300*l*	Do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	104 —107	104 —107	$105\frac{1}{2}$	...
276,200*l*	Do. do. Bearer Nos. 1050—3,975 and 4,327—6,400 ...	100	104 —107	104 —107	$104\frac{1}{2}$	...
320,000*l*	Do. 4 p. c. Debenture Stock	Stock	105 —108	105 —108	$105\frac{1}{2}$	...
135,000*l*	Eastern and South African Telegraph, Ltd., 5 p. c. Mort. Deb. 1900 redeem. ann. drawings, Registered Nos. 1 to 2,343	100	102 —105	102 —105	...	...
180,400*l*	Do. do. do. to bearer, Nos. 2,344 to 5,500	...	102 —105	102 —105	...	...
201,600*l*	Do. do. 4 p. c. Mort. Debs. Nos. 1 to 2016, red. 1909	100	98 —101	98 —101	$100\frac{3}{4}$	$100\frac{1}{2}$
45,000	Electric Construction, Limited, Nos. 101 to 45,100	10	$3\frac{1}{2}$— $4\frac{1}{2}$	$3\frac{1}{2}$— $4\frac{1}{2}$	$3\frac{15}{16}$	...
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	$4\frac{1}{2}$— 5	$4\frac{1}{2}$— 5	...	...
66,750	Elmore's French Patent Copper Depositing Co., Ltd, Nos. 1 to 66,750	2	$2\frac{5}{8}$— $2\frac{7}{8}$	$2\frac{7}{8}$— $3\frac{1}{8}$	$3\frac{1}{16}$	$2\frac{7}{8}$
70,000	Elmore's Patent Copper Depositing, Limited., Nos. 1 to 70,000 ...	2	$3\frac{3}{8}$— $3\frac{5}{8}$	$3\frac{7}{8}$— $4\frac{1}{8}$	4	$3\frac{3}{8}$
67,385	Elmore's Wire Mfg., Ltd., Nos. 1 to 67,385, issued at 1 p.m., all pd.	2	$1\frac{1}{2}$— 2	$1\frac{3}{4}$— $2\frac{1}{4}$	$2\frac{1}{8}$	2
20,000	Fowler-Waring Cables, Nos. 301 to 20,300 ... (£4 10s. only paid)	5	2 — 3	2 — 3	...	...
180,227	Globe Telegraph and Trust, Limited	10	$9\frac{5}{8}$— $9\frac{7}{8}$	$9\frac{5}{8}$— $9\frac{7}{8}$	10	$9\frac{3}{4}$
180,042	Do. do. 6 p. c. Preference	10	$14\frac{7}{8}$— $15\frac{1}{8}$	$14\frac{7}{8}$— $15\frac{1}{8}$	15	$14\frac{15}{16}$
150,000	Great Northern Tel. Company of Copenhagen	10	$18\frac{3}{4}$— $19\frac{1}{4}$	$18\frac{3}{4}$— $19\frac{1}{4}$	$18\frac{3}{4}$	...
220,000*l*	Do. do. 5 p. c. Debs. (issue of 1883) ...	100	106 —109	104 —107 xd	...	...
12,134*l*	Greenwood and Batley, Ltd., Ordinary, Nos. 4667 to 14,000 ...	10	8 — $8\frac{1}{2}$	8 — $8\frac{1}{2}$	...	...
9,600*l*	Do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	10 — 11	10 — 11	...	...
41,600	India-Rubber, Gutta Percha and Telegraph Works, Limited ...	10	19 — 20	19 — 20	$19\frac{3}{4}$	$19\frac{1}{2}$
200,000*l*	Do. do. $4\frac{1}{2}$ p. c., Deb., 1896	100	104 —106	104 —106	...	...
17,000	Indo-European Telegraph, Limited	25	41 — 43	41 — 43	43	$42\frac{3}{8}$
11,334	International Okonite, Ltd., Ordinary Nos. 22,667 to 34,000	10	$7\frac{1}{2}$— $8\frac{1}{2}$	$7\frac{1}{2}$— $8\frac{1}{2}$	...	...
11,334	Do. do. Preference Nos. 5,667 to 17,000 ...	10	$9\frac{1}{4}$— $9\frac{3}{4}$	$9\frac{1}{4}$— $9\frac{3}{4}$	...	...
38,348	London Platino-Brazilian Telegraph, Limited	10	$6\frac{1}{2}$— $7\frac{1}{2}$	$6\frac{1}{2}$— $7\frac{1}{2}$	...	...
100,000*l*	Do. do. do. 6 p. c. Debentures	100	107 —110	104 —107 xd	...	...
43,900	*Metropolitan Electric Supply, Ltd., Nos. 6,101 to 50,000 (£9 paid)	10	$9\frac{3}{4}$— $10\frac{1}{4}$	$9\frac{3}{4}$— $10\frac{1}{4}$	$10\frac{1}{8}$	$9\frac{7}{8}$
447,234*l*	National Telephone, Limited, Nos. 1. to 438,984	5	$4\frac{5}{8}$— $4\frac{7}{8}$	$4\frac{5}{8}$— $4\frac{7}{8}$	$4\frac{7}{8}$	$4\frac{5}{16}$
15,000	Do. 6 p. c. Cum., 1st Preference	10	$12\frac{1}{2}$— $13\frac{1}{2}$	$12\frac{1}{2}$—$13\frac{1}{2}$	13	$12\frac{7}{8}$
15,000	Do. 6. p. c. Cum. 2nd Preference	10	$12\frac{1}{2}$— 13	$12\frac{1}{2}$— 13	$12\frac{5}{8}$	...
420,000*l*	Do. $4\frac{1}{2}$ p.c. Deb. Stock Prov. Certs. fully paid ...	...	105 —107	105 —107	$106\frac{1}{2}$	$105\frac{7}{8}$
6,318*l*	Notting Hill Electric Lighting Company, Limited, £8 paid ...	10	$3\frac{1}{2}$— $4\frac{1}{2}$	$3\frac{1}{2}$— $4\frac{1}{2}$	...	...
220,000*l*	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11s. only paid)	1	$\frac{3}{16}$— $\frac{5}{16}$	$\frac{3}{16}$ — $\frac{5}{16}$	...	...
9,000*l*	Reuter's Limited	8	8 — $8\frac{1}{2}$	8 — $8\frac{1}{2}$	...	...
18,680	St. James's & Pall Mall Electric Light Co., Ltd., Ord., 101—18,780	5	$6\frac{3}{4}$— $7\frac{1}{4}$	$6\frac{3}{4}$— $7\frac{1}{4}$	$7\frac{1}{8}$	$6\frac{7}{8}$
7,900	Do. do. do. 7 per cent. pref.	2	$4\frac{1}{4}$— $4\frac{3}{4}$	$4\frac{1}{4}$— $4\frac{3}{4}$	...	...
3,381	Submarine Cables Trust	Cert.	117 —121	117 —121	117	...
78,949	Swan United Electric Light, Limited ... ... (£$3\frac{1}{2}$ only paid)	5	$4\frac{1}{2}$— 5	$4\frac{1}{2}$— 5	$4\frac{3}{4}$	$4\frac{9}{16}$
37,350	Telegraph Construction and Maintenance, Limited	12	42 — 44	42 — 44	$43\frac{1}{2}$	$42\frac{1}{2}$
150,000*l*	Do. do. do. 5 p. c. Bonds, red. 1894	100	101 —104	102 —105	...	...
58,000	United River Plate Telephone, Limited	5	$1\frac{1}{2}$— $2\frac{1}{2}$	2 — 3	...	...
146,370*l*	Do. do. 5 p. c. Debenture Stock ...	Stock	85 — 95	85 — 95	...	...
3,200*l*	Do. do. 7 p. c. Debs., Nos. 1 to 1,000 ...	100	... ...	... ...	...	...
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	8 — 9	8 — 9	...	...
271,400*l*	Do. do. do. 5 p. c. Debentures	100	97 —100	95 — 98 xd	$97\frac{1}{2}$	...
30,000	West Coast of America Telegraph, Limited	10	$2\frac{1}{2}$— $3\frac{1}{2}$	$3\frac{1}{4}$— $3\frac{3}{4}$	...	...
150,000*l*	Do. do. do. 8 p. c. Debs., repayable 1902 ...	100	97 —102	97 — 102	99	...
67,007*l*	Western and Brazilian Telegraph, Limited	15	$10\frac{3}{4}$— $11\frac{1}{4}$	$10\frac{3}{4}$— $11\frac{1}{4}$	$11\frac{1}{8}$	$10\frac{7}{8}$
30,364*l*	Do. do. do. 5 p. c. Cum. Preferred	$7\frac{1}{2}$	$6\frac{1}{2}$— 7	$6\frac{1}{2}$— 7	7	$6\frac{3}{4}$
30,364*l*	Do. do. do. 5 p. c. Deferred	$7\frac{1}{2}$	$4\frac{1}{4}$— $4\frac{3}{4}$	$4\frac{1}{4}$— $4\frac{3}{4}$	$4\frac{5}{8}$	$4\frac{7}{16}$
189,700*l*	Do. do. do. 6 p. c. Debentures "A," 1910 ...	100	102 —105	102 —105	...	...
237,200*l*	Do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	102 —105	102 —105	...	...
88,321	West India and Panama Telegraph, Limited	10	$1\frac{7}{8}$— $2\frac{1}{8}$	$1\frac{3}{4}$— 2	$1\frac{15}{16}$	$1\frac{3}{4}$
34,563	Do. do. do. 6 p. c. 1st Preference ...	10	10 — $10\frac{1}{2}$	10 — $10\frac{1}{2}$	$10\frac{1}{2}$	10
4,669	Do. do. do. 6 p. c. 2nd Preference ...	10	9 — 10	$8\frac{1}{2}$— $9\frac{1}{2}$	...	...
$1,336,000	Western Union of U.S. Tel., 7 p. c. 1st Mortgage (Building) Bonds	$1,000	117 —122	117 —122	...	...
173,100*l*	Do. do. 6 p. c. Sterling Bonds	100	101 —105	98 —102 xd	...	...
42,853	*Westminster Electric Supply Corp., Ord., Nos. 101 to 42,953 ...	5	$5\frac{1}{4}$— $5\frac{3}{4}$	$5\frac{1}{4}$—$5\frac{3}{4}$	$5\frac{3}{4}$	$5\frac{7}{16}$

* Subject to Founders' Shares.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Blackpool Electric Tramway Company, Limited, £10 (£$6\frac{1}{2}$ paid), $7\frac{1}{4}$—$7\frac{3}{8}$.—City of London Electric Lighting (Pioneer), Shares of £50, fully paid, 60—62.—Ordinary of £10 each, £2 paid, 2.—Elmore's Austrian Copper Depositing, 15s., 25s., £2 share issued at 10s. prem., fully paid, 1—$1\frac{1}{4}$.—Elmore's Priorities, $3\frac{7}{8}$—$4\frac{1}{8}$.—House to House Company (£5 paid) $4\frac{1}{2}$—5.—Liverpool Electric Supply, £3 paid, $2\frac{5}{8}$—$2\frac{7}{8}$.—London Electric Supply Corporation, Ordinary (£5 paid), $1\frac{5}{8}$—$1\frac{7}{8}$.—Manchester, Edison and Swan Company, £9 (£1 paid) $\frac{3}{8}$ — $\frac{5}{8}$.—National Telephone Debentures, $2\frac{1}{2}$ — 3 prem.—Woodhouse and Rawson Ordinary of £5 (£2 10s. paid), $2\frac{1}{8}$—$2\frac{3}{8}$.—£5 Preference, fully paid $3\frac{3}{4}$—4.—Debentures 90—95.—Wards Electric Car, £10 paid, $\frac{3}{4}$—1.

BANK RATE OF DISCOUNT.—$2\frac{1}{2}$ per cent. (2nd July, 1891).

THE FUTURE OF THE ALUMINIUM PROBLEM FROM THE CHEMICAL STANDPOINT.*

(*Concluded from page* 225.)

Discussion.

Prof. **Thomson**: There is a source of heat, it occurred to me during the reading of the paper, which has been neglected and which might probably be turned to account in this direction, and that is the mere concentration of the sun's heat by large mirrors or lenses. The temperature is, of course, almost that of the sun itself, and will certainly fuse aluminium, and we will get it at simply the cost of the use of the apparatus on a sunny day. It is simply an idea which occurs and which may, of course, be shown to be fallacious, but at the same time I can imagine an enormously large lens or mirror which brings its rays to a focus at the bottom, as it were, of a deep crucible, and have our material there subjected to that cheapest heat of the sun from which all our heat is derived through a series of changes which involve great losses.

The **Chairman** (Prof. F. B. Crocker): In connectiou with that I happen myself to have heard of such a process. A gentleman told me he was building an apparatus. I do not know how far he has got, or whether he has attained any results. There is no doubt about the possibilities of high temperature and there is no doubt about the cheapness. I think myself that there is absolutely no question about the possibility of reducing aluminium by carbon, provided you have the temperature. I think the argument that carbon has sufficient chemical affinity to draw oxygen away from the aluminium is fallacious, because, in the first place, as Dr. Wahl says, the Cowles process is a proof that sufficient temperature will reduce aluminium, because I do not consider that the action there is electrolytic at all. In the second place, carbon can reduce sodium and potassium, which, if anything, are higher or almost as high in their affinities, as aluminium. It is simply a question of temperature or condition. Carbon has a peculiar property of apparently developing high chemical affinity at high temperatures. The higher the temperature the more it develops a tremendous chemical affinity for oxygen. And it seems to go up directly with the temperature. I do not believe it is unlimited but it will go up sufficiently high, I think, to reduce alumina to a metallic state. If temperature and carbon are all that are needed, the sun and ordinary carbonaceous material will make certainly a very cheap process for reducing that metal. But the production of that temperature by anything but electrical methods or the sun's heat seems to me discouraging. No metallurgical temperatures reach at all near that, nor is there any likelihood of their reaching it. Regenerating furnaces produce very high temperatures but not high enough for that purpose. It is not impossible. Of course, the principle of regenerating furnaces would apparently allow us to reach very high temperatures, but I doubt if they would work very well, and I should think very high temperatures would possibly be obtained by electrical heating.

Dr. **Wahl**: In connection with this portion of the discussion, I desire to say, simply that, while I have no doubt that the reaction in the Cowles furnace is to some extent an electrolytic action, yet I am of the opinion that it is probably what I have described it to be, and what I believe it is generally accepted to be—a condition of a reduction by the excessive heat which can be produced in the furnace—purely a chemical reaction affected by the enormous heat of the electric arc, the enormous heat, rather, caused by the passage of the current through this resisting material. But what actually takes place in the Cowles furnace or in the Heroult furnace is difficult to see. I would not desire to have myself quoted as making any positive statement. Conditions are exceedingly curious. We may possibly interrupt the operation midway and find one state of things, and keep on and stop at another stage of the operation and see something else. It is probably partly electrolytic and partly chemical. As to the possibility of obtaining a sufficiently high temperature directly, without the aid of electric heating, I think that it is impossible.

Dr. **Leonard Waldo**: Aluminium is a material of structural engineering, and the conditions of its work must conform to those ideas which belong to the shop and seldom belong to the laboratory. Aluminium, as you quite well know, probably has a conductivity equal to copper, bulk for bulk, and it has 2½ or three times the conductivity of copper, weight for weight. I am speaking now of aluminium which is free from silicon and from iron. *A priori*, therefore, it is the best known metal for alloying with copper in order to give copper the structural strength necessary for all forms of electrical engineering. But here the impurities of silicon and iron come in with a particularly damaging effect. The conductivity of the alloys of aluminium and copper as ordinarily made bear no relation whatever to the proportional bulk of the metals themselves. I cannot say much on this question, because it is a question which is being very carefully investigated in our own laboratory. But that is true, and until the producers of aluminium bring the aluminium product over 98, 99 or 99·9—the nearer they can come to it—the electrical engineers have got to be content with quite a low order of conductivity, both in all sorts of places where metal is applied and in their wires where they want strength, and expect to get the conductivity, but fail. The present position of the aluminium bronze is very closely akin to the early years of steel. I heard a question asked of a famous chemist as to whether he could determine the carbon in steel. He said: "Do you really mean that?" "I do," was the answer. The chemist said: "I cannot." Now the analysis of copper is in its infancy. I doubt whether a man could rely on the determination of copper. But the moment you add aluminium and silicon to copper the question is immensely complicated. The first real work, therefore—now that we have a reasonably pure supply of aluminium, or that we can expect to get a reasonably pure supply of aluminium—is to be done on the scientific side of the question. We have got to have accurate methods of analysis, and we have got to have a great deal of work done on the mixture of copper and pure aluminium, and of aluminium as we get it chemically united with silicon and with iron. The colour of the bronze is a royal colour. It is merely dipped in nitric acid to get out all the colour, and you will get an idea from dipping it what the strength and general value of the metal is.

The **Chairman**: In regard to the conductivity of an alloy, I should doubt very much if the average conductivity of its constituents, or any approximation to it, could be expected. For example, pure silver put into copper will very seriously interfere with the conductivity, and pure silver is supposed to be better than copper in conductivity. That seems to be a fatal fact about the conductivity of alloys, that any alloying seems to reduce conductivity very seriously, and the smallest percentage of alloy or impurity—whatever you might call it—has a very great effect upon a reduction in conductivity; and this seems to be true, no matter what metals are put together.

Dr. **Waldo**: Of course, in discussing all these alloys, the best conception to have is that the alloy is a glass rod transparent to electricity. The oxides and other things which come in, and which are precipitated and act as chemical stains, stop the flow of the current, and whether or not the pure aluminium and the pure copper obey that law of disproportionate conductivity is a question which I think no man can pronounce on, because I do not think any man has ever tried it. A great many people have mixed the aluminium and copper and determined the conductivity of the result, but that is a very different thing.

The **Chairman**: If it is a fact that aluminium bronze or alloys of alluminium and copper or other metals can be made having a conductivity approximating the mean of their constituents, it would certainly be a valuable thing in electrical engineering—a thing greatly to be hoped for.

Mr. **Weston**: I have used aluminium quite extensively. I think Dr. Waldo is mistaken about its conductivity. I have found it to be 60 per cent. that of copper. There is very little variation in the various samples I have met with, and that is about the average figure. Of course, I think what Dr. Waldo says about the action of small quantities of silicon or iron in aluminium when mixed with copper to form an alloy may have a very marked influence upon the conductivity and working of the alloy. Silicon has a very marked influence on the working qualities of steel, and, I think, also on the conductivity. There is another matter there that probably might be worthy of investigation, it appears to me. The copper of commerce is commonly assumed to be extremely pure, and within the past few years there has been a quality of copper called tempered copper put on the market, which analysis shows to be substantially the same as good Lake Superior copper. But when you examine it for conductivity, it has about 60 or 75 per cent. of the conductivity of good Lake Superior copper. Now, it has occurred to me that the tempered copper, which is produced by a secret process, so far as I know, is probably a mixture of copper and hydride of copper, which was discovered by Wurtz some few years ago, and is nearly as brittle as glass. A very small percentage of that hydride of copper added to copper would have a very marked influence, I should think, on the physical and electrical properties of copper. An analyst, unless he made a very careful examination of the copper, would be likely to miss such a thing as a small quantity of hydrogen or hydride of copper, and hence the published analysis of this tempered copper, of which we have heard a great deal, have not been made, probably, with sufficient care to detect a minute trace of hydrogen or hydride. That is a field probably well worth exploring to find whether the hydride of copper, which is very probably formed in making copper, does not come into play here, both in the working properties and in the resistance of the alloys or of the metal itself.

Dr. **Waldo**: I would like to say that my own best determination of the conductivity of the best aluminium I could get was ·6604, but I never have seen a piece of aluminium which was higher than ·9903. I have had a number of samples submitted to me which, by perfectly easy analysis, have run as high as ·9975 and ·9908. But a rigorous analysis has always reduced the amount of the purity of the aluminium. I doubt extremely whether any ordinary samples of aluminium which you would handle would run to ·99. My personal judgment is that the conductivity might run very close to that of copper itself, and there has been no evidence on record that I know of which would tend to disprove that, and a good deal of our private work in our laboratory would go to show it.

FOWLER'S PATENT RADIAL MULTITUBULAR BOILER.

A quick steam-raising boiler, affording considerable power in a small space, while at the same time allowing of easy access for cleaning or repair, without being costly or difficult to construct, has been a desideratum for a numerous class of steam users for a long time, more particularly for supplemental purposes on board ship, and for electrical light installations in crowded cities, where space is often restricted and difficult to obtain.

Several attempts have been made to meet the problem represented by these conditions, but the boilers that have been designed have, as a rule, been not only of a complicated type and costly to construct, but have afforded very imperfect facilities either for inspection or cleaning. In the boiler shown in the accompanying illustration, however, the difficulties have been met in a very simple and ingenious manner.

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* See Electrical Review, August 21st, 1891.

The general arrangement of the boiler, which is the invention of Mr. William H. Fowler, of 6, Victoria Station Approach, Manchester, will be readily understood on reference to fig. 1. The firebox, it will be noted, is of conical shape, and is riveted at its upper end to a plain cylindrical portion, which is divided into two compartments by an arch of fire-clay blocks, carried on an angle ring supported on brackets. The flames and gases, after passing through the lower set of smoke tubes radiating from the firebox to the smokebox, embracing the shell at each side, return through the upper set of tubes to the combustion chamber formed in the upper portion of the firebox, and thence pass by the central uptake to the chimney.

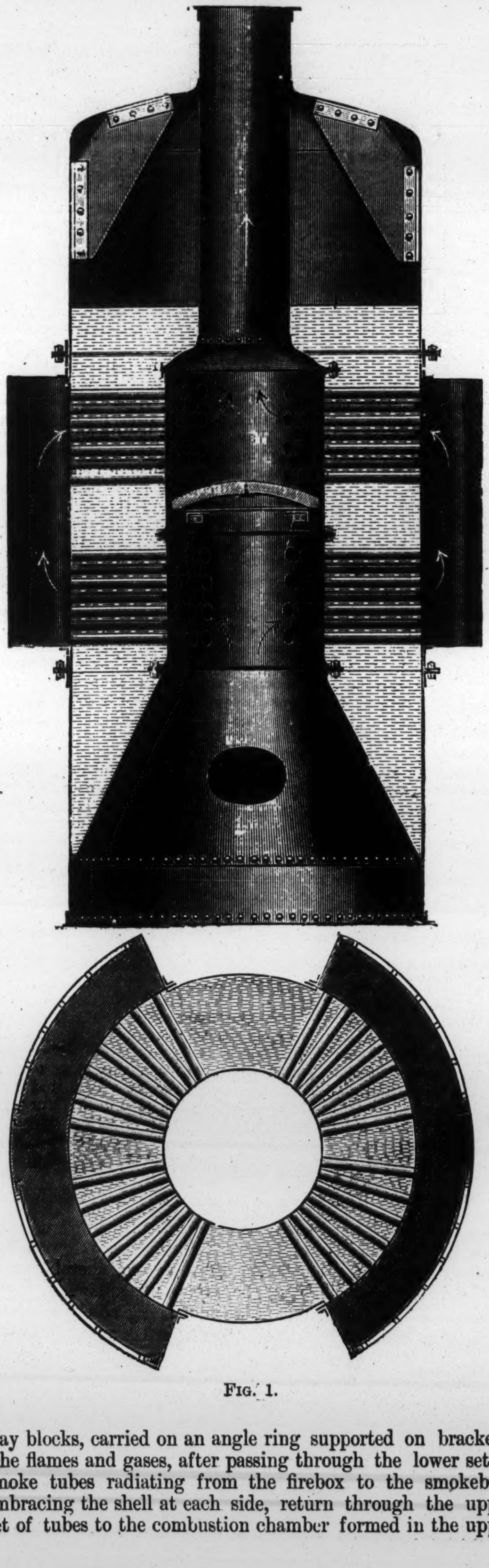

Fig. 1.

It will be noted that there is a complete absence of cross water pipes or other obstruction in the firebox, and thus there is nothing to interfere with perfect combustion, while there is a marked absence of the awkward flanging and expensive construction usually met with in multitubular boilers of this class. The circular form is adhered to throughout both the shell and firebox, so that the boiler can be easily constructed for high pressures, without necessitating the use of heavy scantling. The annular arrangement also, it will be seen, readily permits of all parts of the boiler being easily and quickly inspected, while the circular shape of the firebox permits of the adoption of the flanged joint for uniting the ring seams, thereby affording adequate provision against collapse, and at the same time removing all rivets from the action of the fire.

The arrangement, it will be observed, readily lends itself to the construction of the boiler in three sections, and thus makes it convenient for shipment or transport overland to places difficult of access, the two bolted joints in shell and firebox being easily made on arrival at destination.

THE THEORY OF MAGNETISM AND DIAMAGNETISM.—III.

In the latter part of our last notice of Mr. Parker's criticism of the currently accepted theory of diamagnetism, we gave his modified argument in full. It will have been observed by our readers that it contains a certain tacit assumption, and to this Dr. Lodge has with justice objected. Thus, even if we admit, as we are bound, that the magnetisation of every body takes time to grow, and to die away, it is not proved but that, in the second way of performing the cycle described in our last, the assumed repulsive force between the steel and the bismuth may be so affected by the rapidity of the motion, that the work required to force the bismuth from the position x to the position y may be $> \mathrm{W}$, and *not* less, as was supposed.

This objection is aptly illustrated in the original paper by a hypothetical experiment with a gas in a cylinder provided with a piston.

But Dr. Lodge's objection may be obviated by means of two assumptions :—

1. By assuming that the magnetisation of a body at rest may be in a state of unstable equilibrium, and then a slight shake, by which no perceptible amount of mechanical work is done, will be sufficient to cause magnetisation to rise or sink to its proper value.

2. By assuming that if two magnetised bodies be moved about with any velocities, the attraction or repulsion between them when they are passing through any given position may, if the experiment be made steadily enough, be exactly the same as if both bodies were at rest in that position with their magnetisations invariable.

In applying these assumptions to the second method of making the experiment described in our last notice, let it be supposed for the sake of simplicity, that the magnetisation of the steel is "rigid," that is, not merely unstably invariable, but invariable under all circumstances. Then let the cycle be performed as follows :—

(*a*). Let the bismuth be moved from x to y, so steadily that its magnetisation is unaltered. No thermal phenomenon will attend this operation, and the work done on the system will be $< \mathrm{W}$.

(*b*). The magnetisation being now unstable, let a slight shake, by which no perceptible amount of mechanical work is done, be given to the bismuth, in consequence of which the strength of the magnetisation will be affected, and a thermal phenomenon takes place. Then let the bismuth be held in the position, y, until the temperature is again θ and the magnetisation at its proper value.

(*c*). Let the bismuth be brought back from y to x by the first path reversed, and so steadily that the magnetisation does not change. The work restored by the system during this operation is $> \mathrm{W}$.

(*d*). Lastly, let a slight shake be given, and hold the bismuth in the position x until the system is in the original state.

By making the assumptions, therefore, numbered 1 and 2 above, the hypothesis of diamagnetism enables us to obtain work from a cycle in which heat can only be absorbed or given out at a given constant temperature, θ.

That both the assumptions are admissible can be established indirectly by showing what results they lead to when applied to several of the most important propositions in magnetism and electricity.

I. If in the modified Thomson argument it be supposed that the bismuth is replaced by any substance, S, which is attracted to the pole, P, it will be seen that if the magnetisation of S increases as the distance from P decreases, our two assumptions do not lead to a result in contradiction to the principle of energy and Carnot's principle. Therefore we conclude that a substance is attracted by a magnet pole—a result, of course, which is in accordance with experiment.

Mr. Parker, for the sake of extra lucidity, gives another method of making the experiment in his original paper.

II. If the substance, m, when removed to a sufficient distance from the pole, P, is in the neutral state, then it can be proved that when m is near P, and its magnetisation in stable equilibrium, m must be attracted by P with a force which increases as the distance from P decreases. Such a substance is defined to be "perfectly soft," and since unstable states of magnetisation do not occur in practice, we may say that a "perfectly soft" substance can only be attracted by a magnet pole. Of course, a substance, S, may be repelled by the pole, P, but in that case it can be easily shown the magnetisation of S could not be zero when it is at a great distance from P. The substance, S, would then be a permanent magnet, or its magnetisation would consist of a permanent part combined with a temporary part induced by the influencing pole, P.

III. If we now suppose the pole, P, replaced by a positively electrified body, and the bismuth by a negatively electrified body, B, the force between the two bodies will be attractive, and when B is moved from x to y in such a way that the distributions of the electrifications are in stable equilibrium, the attraction on B in the position, y, will be greater than if the distributions had not been changed. Hence, if W be the positive quantity of work yielded by the system when B is moved from x to y in such a way that at every instant the distributions are in stable equilibrium, then when B is moved from its initial position, x, in which the distributions are stable, to the second position, y, without any change in the distributions, the work yielded by the system will be $<$ W. Also if, after causing the distributions in the position y to become stable, we bring B back from x by the previous path reversed without any change in the distributions, the work so done on the system will be $<$ W. Consequently if the system is now caused to resume its orginal state, a complete cycle will have been undergone, and a positive quantity of work expended in it, which is in accordance with the principles of thermo-dynamics.

IV. Next, let both bodies be positively electrified, and suppose that they are at such a distance from one another throughout the experiment that the force between them is always repulsive. Then, when B is moved from x to y in such a way that the distributions are constantly in stable equilibrium, the repulsion on B in the position y will be less than if the distributions had not changed. From this it is easily seen that electric repulsion is in accordance with the principles of thermo-dynamics.

V. Again, if we assume the principle of the conservation of electricity which can be partially obtained as a theoretical deduction from the principle of energy and Carnot's principle, the two assumptions enable us to find expression for the energy and eutropy of an electrified system at rest, in which the distribution of electricity is in equilibrium, stable or unstable. Then the condition of electric stability on an insulated homogeneous conductor can be easily found. For if P and Q be two points of such a conductor, the expressions show that if the potential have a higher value at P than at Q, it will be possible for electricity to pass, of itself, from P to Q, but not from Q to P. Conversely, if the potential at P be less than at Q, electricity will be able to pass, of itself, from Q to P, but not from P to Q. Suppose, for example, that the potential at P is $>$ potential at Q, then a slight shake may cause a passage of electricity from P to Q, and this will diminish the potential at P and increase it at Q. Thus the potential tends to become uniform throughout the conductor, and when it has become uniform the distribution is stable.

VI. Again the expressions for the energy and the eutropy enable us to discuss the conditions of stability of two conductors a b, separately homogeneous, which are in contact with each other and isolated from all other bodies. For if P be a point in the body a, and Q a point in the body b, our expressions show that if the potential at P exceed the potential at Q by more than a certain amount, electricity will be able, of itself, to pass from P to Q, but not from Q to P, and conversely. Thus the condition of stability is that the potential should be uniform throughout each conductor, and that the two values should differ according to a certain law, all which is verified by experiment. Again, if the distribution be indefinitely near stable, and we suppose a small charge to pass from one conductor to the other, our theory indicates that it will be necessary to impart or take away heat to keep the temperature of the junction of the two bodies constant. In other words, the theory gives both the difference of potential and the Peltier effect.

It is important to remark that, by merely assuming our expressions for the energy and eutropy to hold for stable distribution, and without making any further use of the conception of unstable distribution, the same expressions for the difference of potential, and the Peltier effect, may be obtained as before.

Similarly we have two methods of discussing the question of a difference of potential, and the law of the Thomson effect in the case of two unequally heated portions of the same substance in contact, and both methods give the same results.

7. Lastly, we have two ways of investigating Helmholtz's theory of the galvanic battery, and both lead to the same conclusions. This theory, it is true, has been questioned, but, as Mr. Parker observes, the objections appear to rest on misconceptions; and, moreover, the theory does not seem to have been yet sufficiently explained.

Whilst acknowledging the importance of Dr. Lodge's objection which requires the examination of the tacit assumptions which lie at the root of all thermo-dynamical investigations of electricity and magnetism, Mr. Parker considers that his two new assumptions are now shown to be legitimate.

In concluding this part of his investigation into the theory of magnetism, Mr. Parker observes that no one has ever attempted to advance any serious arguments in favour of the common notion of diamagnetism, and he considers that the notion owes its origin to the want of a theoretical examination of the subject, and to have been maintained from an excusable veneration for an old theory and a belief in the infallibility of the older scientists. We shall look with interest to Mr. Parker's next communication.

GERMAN MUNICIPAL REPRESENTATIVES AT THE FRANKFORT EXHIBITION.

[FROM A CORRESPONDENT.]

AT the invitation of the town authorities, an important assembly took place on the 27th, 28th, and 29th ultimo, in the Victoria Theatre in the Frankfort Electrical Exhibition. From all parts of Germany, from north to south and east to west, the representatives of German municipalities had journeyed to the city to be informed of the present position of the electro-technical industries. They did not go to discuss and adopt resolutions, their object being to hear and see for themselves what electricity can perform. As a memento of the occasion an excellent book, entitled "The Supply of Electric Current to Towns," by Mr. F. Uppenborn, was distributed among those present. The object of this work might be thought to be sufficiently explained by its title, but such is not the case. It enabled the members of the meeting or "municipal day," as it was termed, to make a rapid survey of the different systems of supply, and to complete the survey by a practical demonstration in the exhibition buildings. The book occupies 271 pages and contains reports on 21 different branches in the exhibition, together with illustrations and plans.

After a hearty welcome at the morning sitting had been given to the visitors by the Mayor of Frankfort, Herr Adickes, and by Herr L. Sonnemann, president of the exhibition, a report was presented by Mr. F. Uppenborn of the *Elektrotechnische Zeitschrift*, concerning the exhibits of most importance to town authorities. The report treated of continuous, alternating and rotary currents, arc and glow lamps, motors, &c., with special reference to the exhibits. This was, however, not all. In order to practically explain the details of the report, an inspection of the exhibition was then made under the guidance of Herr Oscar von Miller.

On resumption, at 2 p.m., a discussion arose on a subject which is now being seriously considered in the large towns, namely, on the Telegraph and Electric Light Installations Bills. Chief engineer Andreas Meyer, of Hamburg, after dealing with the general and technical sides of the question, said that the streets were the property of the towns, that formerly only the surface was used, that at present underground installations were increasing, and that therefore with the exception of gas mains and sewers, it was necessary to construct underground subways for the accommodation of the various pipes or conductors. The post office authorities now claimed a preference right over these pipes and rendered difficult the erection of other installations, because interruptions in the telegraph cables due to strong currents in adjoining conductors had occurred. It was a pity, he said, that Steinheil had discovered the earth to be a conductor, otherwise the post office would have provided metallic circuits and thereby assured its service. The post office could make itself independent of strong currents, and if all contractors were required to do the same the post office could not complain.

Chief Burgomaster Becker, of Cologne, then went into details regarding both Bills.* The first proposed to afford to the Government a monopoly over telegraphy and telephony. There was, in the opinion of the speaker, no objection to the transfer, provided the Bill contained two clauses: First, that municipalities should have the right of disposal of their streets and that this right should be recognised; and second, that the various electric cables should have a proper metallic return and be protected from the influence of neighbouring conductors. If then, those two clauses were inserted in the Telegraph and Telephone Bill, the Electric Lighting Bill would be superfluous. Should, however, the latter come on for consideration, it was essential to demand that also in that instance the right of disposal of its streets should be stipulated for the municipal authorities, that the preference of the post and telegraph administration should be removed, and that the "trade regulation," which was in force in other trades, should also be applied to the electrical industry. The municipalities wanted a careful examination and an impartial decision. The Rhenish Burgomaster had expressed the wish that representatives of the towns should be given a hearing on the subject. On the other hand a petition could be forwarded to the Imperial Diet embodying the opinions of the towns from their point of view, as in its present form the Bill gave rise to serious considerations.

As a proof of the approval of these recommendations, the town representatives frequently applauded the speaker. Chief Burgomaster Staude, of Halle, and Messrs. Uppenborn and Von Miller also participated in the discussion and the sitting terminated at 4 p.m.

On Friday morning, Herr Oscar von Miller explained to the representatives of the municipalities the different systems of distributing current, the paper being illustrated by diagrams. In his opinion there was no one system which could be said to be the best. Afterwards, another tour of the exhibition was made to practically demonstrate the details placed before the meeting in this paper. In the afternoon Herr W. H. Lindley dealt with electric railways. A discussion ensued in which the representatives of Messrs. Siemens and Halske, and the Thomson-Houston Company participated.

On Saturday the proceedings were brought to a close by visits to various municipal works. The Popp compressed air installation at Offenbach was also inspected.

LIGHTNING ARRESTERS.

By A. A. CAMPBELL SWINTON.

ACCIDENTS due to lightning striking electric light wires are, in England, somewhat rare; in fact so seldom do such accidents occur that the employment of arresters in this connection is as a rule not considered necessary in this country. When it is found advisable to employ them, however, they should be of a type specially designed for electric light circuits, as the employment of arresters of the ordinary telegraphic form may do more harm than good, as was recently instanced at "Cragside," Lord Armstrong's place in Northumberland.

One of the circuits at this installation is a double line about one quarter of a mile in length, laid for the greater part of the distance underground but supported overhead on poles for about 100 yards at one extremity. Both of the wires forming the circuit were at each end fitted with lightning arresters of the ordinary standard Post Office pattern consisting of two brass discs super-imposed on one another, and separated by a thin perforated plate of mica, one disc being connected to the line, and the other to the earth. The lightning seems to have struck both wires simultaneously where they pass overhead and to have gone to the earth from the two wires through arresters at opposite ends of the line, thereby for an instant short circuiting through the earth the storage batteries that were connected to the circuit. The battery discharge once originated in this manner seems to have maintained itself by means of an arc in each arrester, with the result that the battery charge ran completely out in the course of a few hours, and one of the arresters was heated to such an extent that it burnt a deep hole in the wooden box in which it was placed.

This occurrence demonstrates the uselessness of ordinary telegraphic arresters for electric light purposes. For the latter arresters must be fitted with some device for extinguishing any arc that may be formed either by separating the points, or in some other manner, otherwise the resulting short circuit may do as much or even greater damage than the lightning itself.

CROMPTON'S ELECTRICAL HAULAGE PLANT.

MINING engineers are beginning to appreciate the immense advantages offered by electrical transmission. For some time past experiments on a small scale have been carried out in different mines, and sufficient information has been obtained to warrant the introduction of a much larger plant, and the haulage machinery recently installed at Abercanaid Colliery for the Hill's Plymouth Company in South Wales is the latest development. Mr. J. C. Howell, of Llanelly, Messrs. Crompton's South Wales agent, undertook to supply the owners with haulage machinery which would replace 27 horses, many haulers, and a number of door-boys, and enable the output to be increased by 100 tons per day.

After careful consideration it was decided to accept the offer, and Messrs. Crompton & Co., at Chelmsford, set to work to design the most efficient plant for the purpose named. Many points had to be most carefully considered, and besides the necessity of making the plant very compact, the haulage machine was required to be most easily controlled. The winding gear was the usual form employed in the main and tail rope system, and this was found to work exceedingly well. The motor is a Crompton patent series-wound machine built to run at 600 revolutions per minute, and take 80 ampères at 450 volts at starting; when a heavier current is required it will take 160 ampères without harm. The motor is placed horizontally at one end of a wrought iron frame which forms the bed for the drum and spur wheel. The drum shaft which is of steel is driven from a countershaft by means of spur gearing, and the motor drives the countershaft by means of six one-inch ropes. The haulage engine is fitted with two drums 3 feet 6 inches diameter and one foot wide, which are controlled, as above stated, by clutch and foot brake. This plant will haul coal from three different parts

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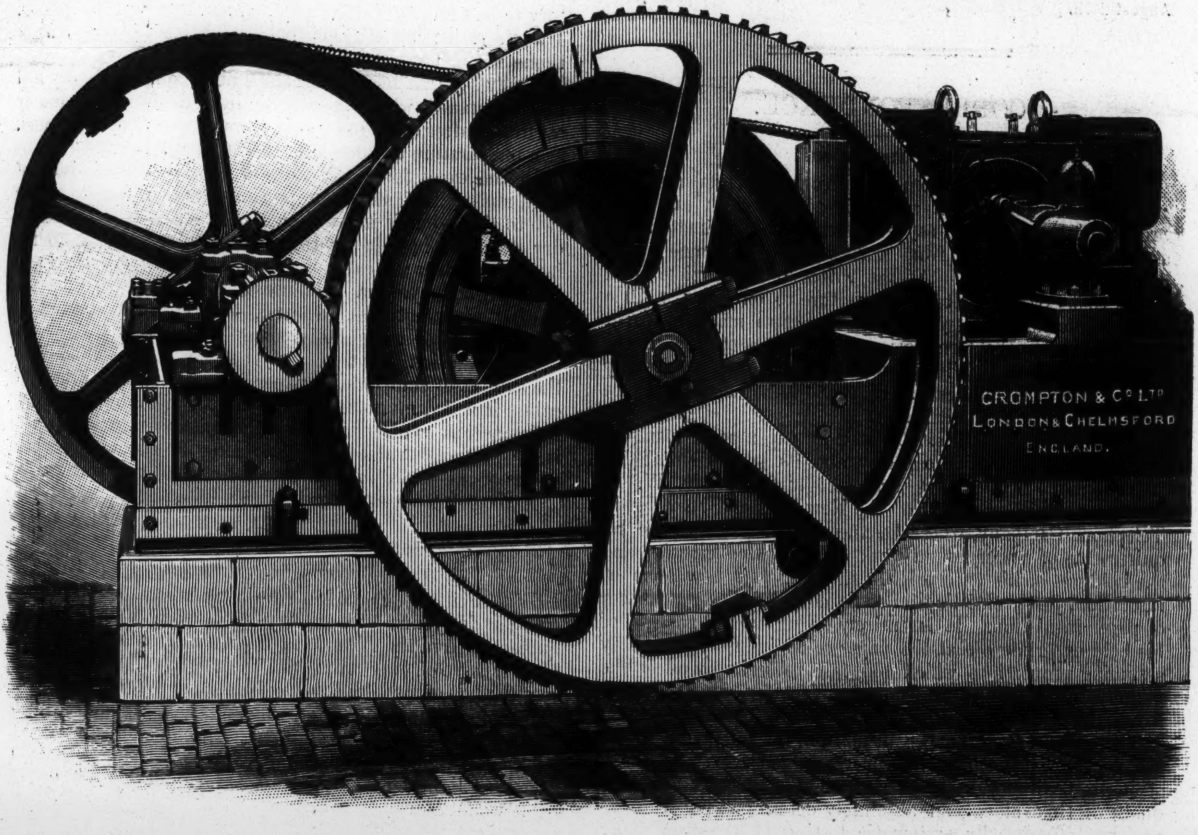
[We were under the impression that there was only one, but it appears there are two distinct Bills.—EDS.]

of the pit, and although these are not far from the motor at the present time, it is expected that coal will have to be dealt with nearly a mile distant. The generating plant comprises a Crompton dynamo, horizontal pattern, built on a wrought iron bed-plate. It is compound wound and will give out 160 ampères at 500 volts, running at 550 revolutions. The cable connecting the dynamo with the haulage plant is 3,200 yards long and composed of 37 strand, No. 14 high conductivity copper wire highly insulated with vulcanised bitumen, double taped and served with two layers of jute yarn compounded between each. It is protected by a double sheath of No. 8 steel wire, the first stranding being of 30 wires, and the second 36 wires laid in reverse directions. The current density is 870 ampères per square inch, and resistance of cable ·3192 ohms allowing a loss of potential of 51 volts or 10 per cent.

From the generating plant the cable is carried down the level by the side of the shaft, and between the hauling engines it is fixed on each side of the roadway, and in case of "falls" the cable has been constructed so that it can stand a shearing strain of 10 tons per square inch.



A number of visitors were invited by the Hill's Plymouth Company to see the opening ceremony, amongst whom were many connected with collieries in different parts of the country, and many well known mining engineers. The engineer to the company, Mr. Bailey, stated that his father had put down the first system of rope haulage for mines 30 years ago, and the electric system of haulage now inaugurated would enable the company to increase its output very considerably. The great difficulty in colliery enterprises was the labour cost, and the coal could not be got to the surface unless they had mechanical means of bringing it up long distances. The system of rope haulage by compressed air was very costly, and they were thrown on their beam ends, as it were, when Mr. Howell, of Llanelly, offered to supply this electrical plant. They found that the capital required was only half that of compressed air, while the latter only gave 30 per cent. efficiency, electricity gave 65 per cent., which was a most important improvement. He added that he placed perfect reliance on Mr. Howell's estimates and working, the more especially as, since Mr. Howell had erected their electric lighting arrangements at Abercanaid, they had never had one hour's stoppage, which spoke well for the machinery and for Messrs. Crompton's work. The machinery must be well made, and put up well to act in this manner. He hoped and believed that the electric haulage machinery started that day would prove the most economising machinery ever brought into South Wales. They found it impossible to go on with horses, and were glad that they had put down an electric haulage plant, and would have great pleasure in showing and explaining it to any others interested in such matters.

Mr. Howell stated that this was the first experiment on so large a scale underground, and although they had no opportunity of making a trial before that day, he found the machinery was in perfect order and answered every expectation. The most important point for colliery owners to consider was the fact that the electric haulage plant costs only one half that of compressed air machinery. Coal owners had to apply powers at great distances from the source of energy, and for that purpose he looked upon the electrical machinery which had just been erected as a commencement of what would become general in the colliery work of South Wales. They could deliver at the far end 60 or 65 per cent. of the power generated, which was what no other power known could do.

After it had been started, a number of engineers and others interested went down the pit and saw the work done by the haulage engines, of which they spoke in the highest terms.

NEW PATENTS—1891.

13,865. "Improvements in apparatus for giving notice, by means of electricity, of the heating of bearings." E. Edwards. (Communicated by A. Backhaus, Germany.) Dated August 17th. (*Complete.*)

13,880. "Aëro dynamic motive power apparatus." J. Desmaroux. Dated August 17th.

13,917. "Improvements in telegraphing." D. H. Smith. Dated August 18th. (*Complete.*)

13,926. "Improvements in electric locomotives and in electric conductors for use therewith." L. B. Atkinson, C. W. Atkinson, and F. Hurd. Dated August 18th.

13,927. "A unison apparatus for printing telegraphs." H. van Hoevenbergh. Dated August 18th.

13,936. "Improvements in and relating to electric motors, chiefly designed for use in connection with ventilating fans." C. J. KINTNER. Dated August 18th. (*Complete.*)

13,942. "Improvements in or connected with apparatus for completing and interrupting electric circuits." T. PARKER, J. H. WOODWARD, and E. S. G. REES. Dated August 18th.

13,961. "Appliances for an electrical parcel exchange system." A. R. BENNETT. Dated August 19th.

13,969. "An improved appliance for use as a thermo-transmitter or radiator for domestic purposes." D. NICHOLS. Dated August 19th.

14,023. "Improvements in electrometers." C. RAAB. Dated August 19th.

14,040. "Improvements in electric lighting and extinguishing apparatus for gas-burners." H. H. LAKE. (Communicated by A. Orling, Sweden.) Dated August 19th.

14,042. "Improvements in electric lamp-holders." O. T. COOPER. Dated August 19th.

14,063. "Improvements in telephonic transmitters." A. MARR. Dated August 20th.

14,067. "Improvements in moulds and machinery for the manufacture of glass switch slabs for electrical and other purposes." D. RYLANDS and B. STONER. Dated August 20th.

14,084. "Improvements in electrically actuated time checking apparatus." J. APPLETON and W. T. BURLEY. Dated August 20th.

14,089. "Improvements in electrical measuring apparatus." A. RECKENZAUN. Dated August 20th.

14,096. "Combination electric lock." J. G. THOMPSON. Dated August 20th.

CORRESPONDENCE.

Paper Insulation.

I regret that absence from New York has prevented my noticing before this your editorials of May 29th and July 3rd, on paper insulation, as practised in the United States, as well as your extract from a New York exchange (page 691, May 29th, 1891). As the writer of the article from which that extract was taken, I venture to offer you a little further information regarding the progress made in paper insulation since the termination of my connection with the Norwich Insulated Wire Company, which followed very closely after the publication of the original article in the New York technical journals.

The very high qualities possessed by paper as an insulator of low specific inductive capacity, and its special suitability for telephone work, were first recognised by Mr. W. D. Sargent, the vice-president of the New York and New Jersey Telephone Company, whose keenness of insight into the requirements of underground work on telephone circuits, and the boldness of his enterprise in adopting this new form of insulation, justly entitles him to be considered as the father of paper insulation. It is entirely owing to the success of his bold experiment that the paper cable industry is rapidly assuming proportions which bid fair to seriously affect the manufacture of rubber and compound cables, which, indeed, it has already superseded in telephone work.

The advantages of paper insulation for telephone cables are very low capacity, and for other purposes, cheapness, strength, flexibility, and lightness. The permanence of these qualities time alone can absolutely determine, but the experience afforded by systematic testing of the first paper covered cables laid some four years ago, and which were naturally somewhat crudely made, points rather to improvement by age than to deterioration. As you are doubtless well aware, what is called "conference standard" telephone cable of the States consists of 52 pairs, 104 conductors, of No. 18 Brown and Sharpe gauge 40, ·303 mils. diameter, insulated to ·125. Each pair of conductors is twisted, and the whole laid up in a cable in reversed layers, and contained in a sheath of lead one-eighth of an inch thick, and measuring two inches outside diameter. It was on cables of this design that the capacity of less than ·085 per mile, alluded to in your editorial, was obtained.

All the principal manufacturers in the States are now willing to supply conference standard paper cables with a guaranteed lower capacity even than that, and wires furnished by the company with which I am now connected have shown a capacity as low as ·071 per mile when laid.

I may mention that these tests were taken by the telephone company for whom the cable was made after it was laid and connected up and before its acceptance from the manufacturer. Recent modifications of the above conference standard, which allow the use of No. 19 wire 45, ·39 mils. diameter instead of No. 18, and generally allows the manufacturer greater latitude, will, of course, reduce the capacity still further, but to what extent has yet to be proved.

In another instance in which the telephone company left the details of construction entirely to ourselves, except the gauge No. 18 and the external diameter two and a half inches, including lead one-eighth of an inch thick, we guarantee a minimum capacity of ·06, and confidently expect very shortly to obtain less than ·05. It will suffice to say that these results are the outcome of persevering experiment and expensive practical tests, possible only where great mechanical and electrical resources are combined with energy and ample capital.

It would seem, therefore, useless to look for further improvement from small and struggling companies unpossessed of such facilities.

It is a far more difficult problem to reduce capacity from ·08 to ·05 than from ·25 to ·08.

As regards paper insulated electric light cable, I may mention that 1,000 feet length of No. 6 wire made under one of my patents, with an insulation 127 mils. thick, has resisted the highest voltage that could practically be brought to bear upon it, and finally only broke down under a laboratory test at a calculated voltage, which, to avoid discussion, I would rather not mention, but amounting to some tens of thousands of volts.

I may say that telephone cables above quoted are dry and uncompounded, whilst the electric light cables are invariably saturated, after drying out by immersion in boiling compound, at a temperature of 200° Fah. to 280° Fah.

In the early forms of cable the compound consisted of resin and resin oil in the proportion of about one to two or two to three, but it is found that the resin is apt to become dry and hard in cold weather, thus risking damage to the insulation when the cable is bent, and offensively sticky and fluid in hot weather. Its use is now abandoned by the leading manufacturers. Indeed, with it, such a result as that just quoted would be impossible.

In conclusion, I would add that my investigations into the subject of compounded paper insulation for electric light cables have led me to conclude that the measured insulation resistance, as usually taken by the reflecting galvanometer, is of no great value as an indicator of the volt-carrying power of the cable, and bears no definite relation thereto.

Apologising for the length of this letter,

J. D. Bishop, *per* M. A. I. B.

August 8th, 1891.

With reference to your editorial comments on paper insulation in your issue of May 29th, page 676, and your quotation from the *New York Electrical Review*, on page 8 of your issue of July 3rd, I take the liberty of quoting part of specification of my U.S. Patent, No. 449,400, dated March 31st, 1891, and the application for which was filed September, 1890.

Quotation.—"Its object is to insure a high insulating power, low inductive capacity, cheapness of construction, and increased lightness and flexibility. An ideal conductor or cable would be one in which the conductor was maintained throughout the whole length equidistant from the protecting sheathing by a material offering a maximum electrical resistance and a minimum inductive capacity. Dry air possesses these qualities to a higher degree than any other known material, and would be the ideal medium of separation of the conductor from the inclosing sheath or adjacent conductors, provided the conductor could be maintained throughout its length with an intervening layer or stratum of such air between it and its inclosing sheath. The nearer an insulated conductor approaches this form the greater will be its advantages in a high resisting power to leakage and a lower inductive capacity, and it will also be of materially decreased weight, of increased flexibility, and diminished cost.

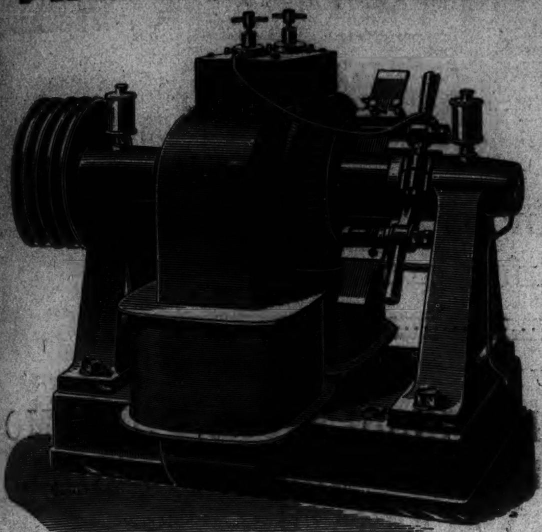
"It is the object of my invention to surround the conductor as much as is practically possible with such a protective envelope of dry air and yet maintain it in a fixed relation to its inclosing sheath."

Experience has proved beyond all possibility of doubt that it is only by acting upon the above theory that low capacity cables can be designed.

J. D. Bishop, *per* M. A. I. B.

August 15th, 1891.

PHŒNIX DYNAMOS



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4S	2,100	50 to 110	35	1,600	3½	33	3 0	3 10
5S	3,000	60 to 110	50	1,520	5	44	3 5	4 0
6S	4,500	60 to 110	75	1,430	7½	55	3 15	4 10
7S	6,000	60 to 120	100	1,360	10	65	4 5	5 0
8S	9,000	60 to 120	150	1,260	15	85	5 0	5 10
9S	12,000	60 to 120	200	1,180	20	105	6 0	6 0
10S	18,000	80 to 150	300	1,020	30	146	8 0	—
11S	24,000	80 to 180	400	900	40	186	10 0	—
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8D	18,000	65 to 110	300	650	30	170	8 0
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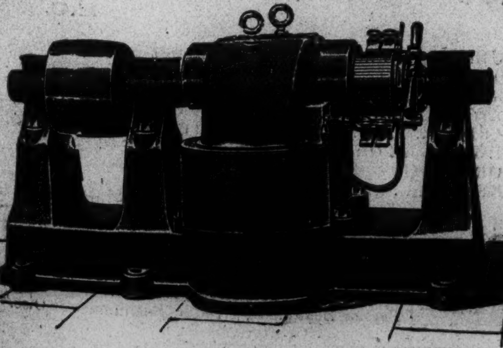

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NEWPORT, MON	119, Dock Street.
CARDIFF	Pierhead Chambers, Bute Docks.
NEWCASTLE-ON-TYNE	6, Neville Street.
NORTH SHIELDS	Borough Road.
LEEDS	9, Trinity Street.

WORKS.

SILVERTOWN, ESSEX. PERSAN-BEAUMONT, FRANCE.

TELEGRAPH ADDRESSES.

HEAD OFFICE—"Silvergray, London."
BRANCHES—"Silvergray" (followed by Name of Town).

WORKS—Silvertown, "Graysilver, London."
Persan-Beaumont, "India, Beaumont-sur-Oise."

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